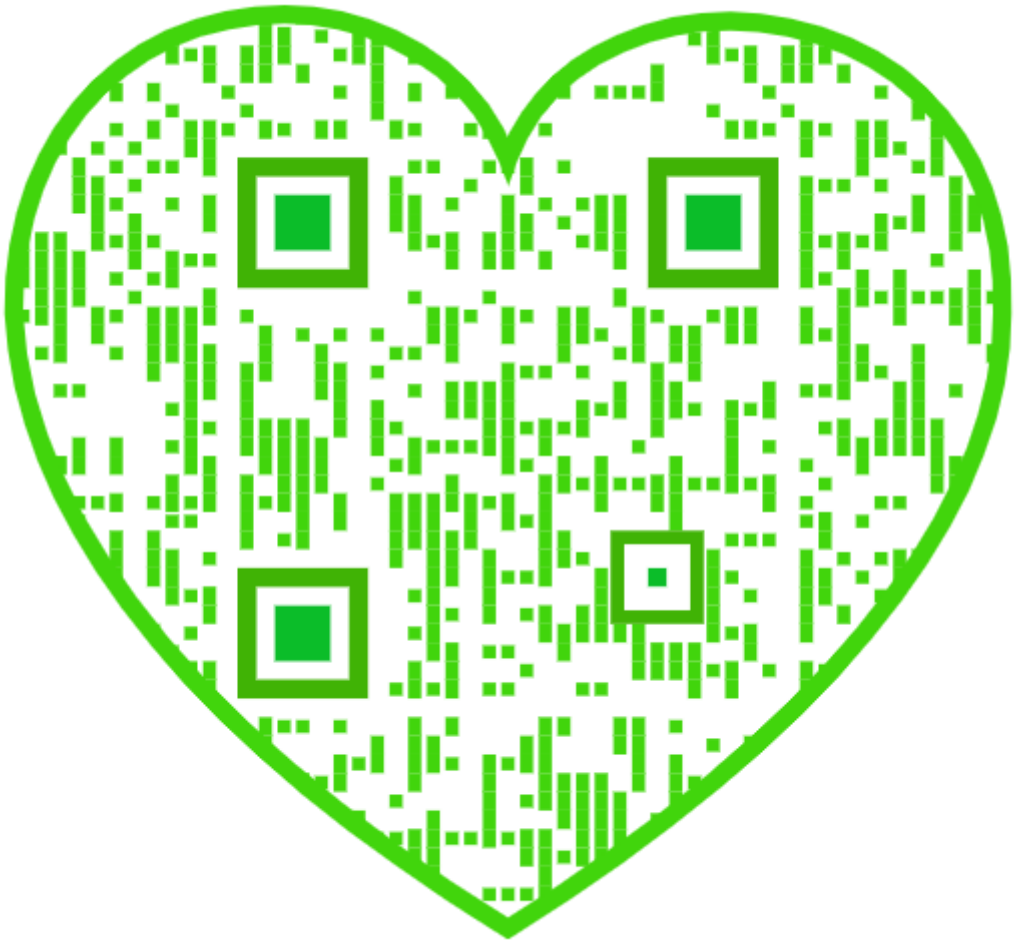

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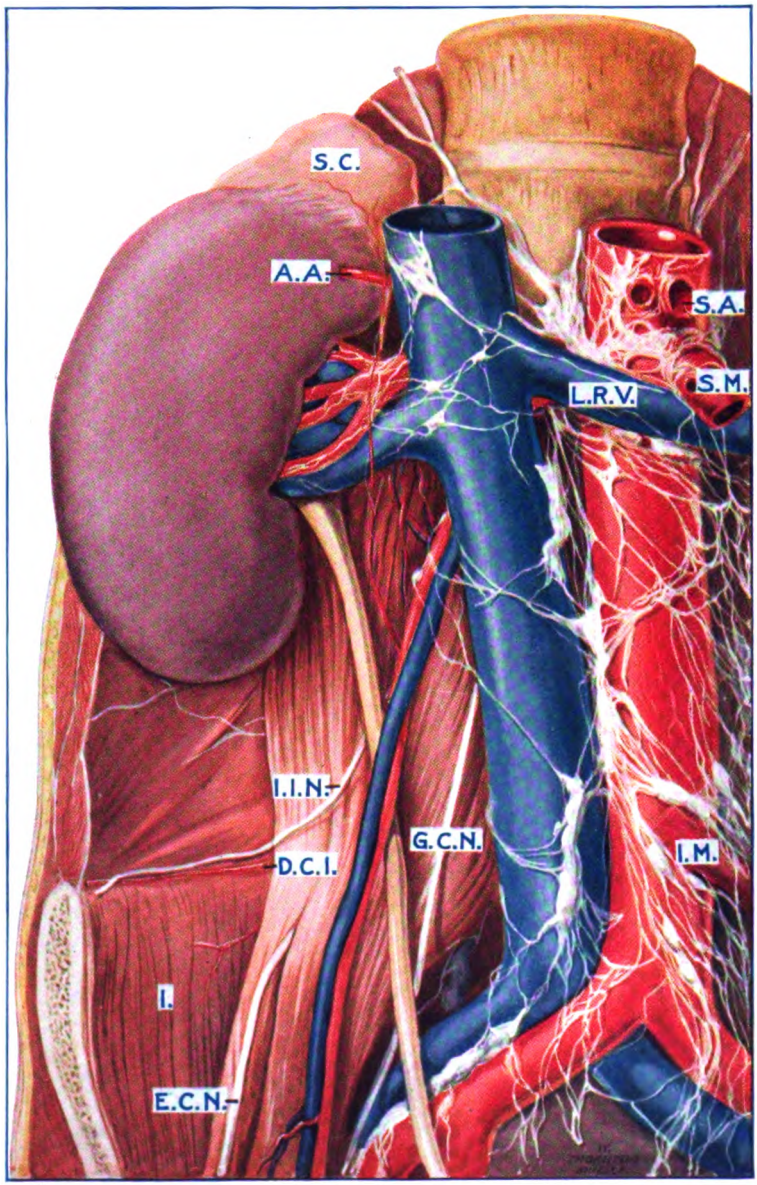

THE RIGHT KIDNEY, FROM THE FRONT.

(From a Dissection in the Museum of the Royal College of Surgeons.)

S.C., SUPRARENAL BODY. A.A., SMALL ABERRANT ARTERY TO THE TOP OF THE KIDNEY. S.A., SPLENIC ARTERY. S.M., SUPERIOR MESENTERIC ARTERY. I.M., INFERIOR MESENTERIC ARTERY. L.R.V., LEFT RENAL VEIN. I.I.N., ILIO-INGUINAL NERVE. G.C.N., GENITO-CRURAL NERVE. E.C.N., EXTERNAL CUTANEOUS NERVE. D.C.I., DEEP CIRCUMFLEX ILIAC ARTERY. I., ILIACUS MUSCLE.

THE COURSE AND RELATIONS OF THE RIGHT URETER, AND THE SHORTNESS OF THE RIGHT RENAL VESSELS, ARE WELL SHOWN.

A MANUAL OF OPERATIVE SURGERY

BY

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THIRD EDITION

WITH NEW COLOURED PLATES AND MANY NEW ILLUSTRATIONS IN THE TEXT

IN TWO VOLUMES
VOL. I.

LEA & FEBIGER
PHILADELPHIA AND NEW YORK
1909

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PREFACE TO THE THIRD EDITION

At the request of Sir Frederick Treves, I undertook the responsibility of a complete revision of this Manual, of which the Second Edition has for some time been out of print. For the delay in the appearance of the Third Edition I must ask indulgence, in view of the great amount of work involved, and the extensive changes and additions that have had to be made. The ever-growing importance of Abdominal Surgery rendered it advisable that the operations on the abdomen should be grouped together in the first volume. Some sections have been curtailed or omitted, such as that relating to Lateral Lithotomy, but most of them have been added to, and several are wholly new. A considerable number of fresh illustrations have been inserted, and a series of coloured plates has been introduced to make clearer the anatomy of certain important operations. These coloured plates have all been drawn specially for this Edition from dissections in the Museums of the Royal College of Surgeons and the London Hospital Medical College. I beg to thank the Councils of those institutions for their kindness and courtesy in this matter.

So far as present surgical experience goes I have selected for description the best methods of performing the various operations, but I have endeavoured to avoid encumbering the work with foot-notes and details as to the exact forms of incision, etc., employed by many individual surgeons. Both surgery and medicine, I venture to think, have been greatly hampered in the past by the needless introduction of names.

*

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The sections on Ovariotomy and Hysterectomy have been revised by Dr. H. Russell Andrews, those referring to Renal and Vesical Operations have been revised and extensively altered by Mr. F. S. Kidd and myself, the section dealing with Operations on the Rectum has been revised and largely rewritten by Mr. A. J. Walton. To those gentlemen I am sincerely grateful for their help.

Whilst so many additions and alterations have been made in this Edition that it is really a new work, it is hoped that everything of permanent value in previous Editions has been retained, and that its practical character and its utility have been enhanced.

J. HUTCHINSON.

1, PARK CRESCENT, W.
January, 1909.

EXTRACT FROM PREFACE TO THE FIRST EDITION

THE present work concerns itself solely with the practical aspects of treatment by operation, with the technical details of Operative Surgery, and with such part of the surgeon's work as comes within the limits of a handicraft.

With the indications for operating I have not dealt, nor have I entered into the mysteries of surgical statistics.

For the selection—out of the vast and bewildering collection provided by the literature of Surgery—of particular methods of operating I must hold myself answerable. I have selected such measures as have appeared to me to be the best, and have made no attempt at encyclopædic completeness.

The majority of the descriptions are founded upon personal experience in the operating theatre, and upon repeated operations on the dead. The account of such particular methods as are associated with the names of individual surgeons I have endeavoured to give in the actual words of the authors.

In each section I have included details as to the preparation of the patient and the after-treatment of the case, and have discussed the comparative merits of the various operations described.

The illustrations have been executed by Mr. Charles Berjeau, to whose artistic skill and much-tried patience I am greatly indebted. The majority of them have been made from sketches of my own. Such as have been derived from other sources are, I hope, fully acknowledged.

FREDERICK TREVES.

October, 1891.

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A MANUAL OF

OPERATIVE SURGERY

PART I.—GENERAL PRINCIPLES

CHAPTER I

THE PATIENT

I.—CONDITION OF THE PATIENT AS IT AFFECTS THE RESULT OF AN OPERATION

"NEVER decide upon an operation, even of a trivial kind," wrote SIR JAMES PAGET, "without first examining the patient as to the risks of his life. You should examine him with at least as much care as you would for a life insurance. It is surely at least as important that a man should not die, or suffer serious damage, after an operation, as that his life should be safely insured for a few hundred pounds."

In the case of urgent operations, performed for the immediate purpose of saving life—as in the relief of a strangulated hernia—few considerations weigh with the surgeon save the one great need. But before undertaking operations of expediency, such as the removal of innocent tumours, the closure of a cleft palate, and the like, it is of infinite importance that every possible consideration be given to all circumstances which may affect the patient's well-being and the success of the operation.

No operation is without risk: some involve special risks;

some overwhelming risks. It is the surgeon's duty to estimate the proportion between the danger incurred by the operation on the one hand, and by the disease if left untreated on the other.

The risk attending the removal of a deformed toe should be infinitesimal. In properly selected cases it is certainly trifling. The operation, however, may be followed by danger to life if it be carried out in the subject of chronic kidney disease.

If the mortality attending the removal of large ovarian tumours were far higher than it is, the operation would still be justifiable, inasmuch as the death-rate in untreated cases is so high as to leave but little prospect of life.

On the other hand, were the death-rate of hysterectomy lower by threefold than it is, it would not sanction the performance of that operation on account of a small fibroid tumour which had ceased to grow, which produced no symptoms, but which the patient, as a whim, was determined to be freed from.

If a patient wishes to be rid of a mere inconvenience, or of some real or imagined blemish, it is exceedingly important that the precise risk at which relief may be obtained should be clearly ascertained.

Besides the risks to life, there are possibilities to be considered which may be termed local risks.

The operation for the relief of Dupuytren's contraction of the palmar fascia has led to sloughing of the tissues of the hand and a crippling of the limb infinitely more severe than that attending the original disease. Even in cases where perfect healing has been secured, want of care in after-treatment has sometimes led to stiffening of all the fingers in an extended position—a condition more disabling than the original contraction of one or two of them.

We have known an operation for the removal of a small exostosis of the femur, which caused little inconvenience, lead to suppuration of the knee and a final ankylosis of the joint.

An operation for harelip carried out under unfavourable circumstances has left the deformity worse than it was before.

It must not be assumed that precise attention to the securing of asepsis covers all precautions and leaves nothing more to be done.

It is, in fact, of the utmost importance that every care should be taken to arrive at a knowledge of the physical condition of the individual upon whom even a small operation is to be performed. Every surgeon must have met with instances where he has regretted the neglect of this fundamental precaution. I (F. T.) once snipped off with the scissors a small fibrous epulis growing from the gum of a little boy. I discovered afterwards —what I should have known before—that the patient was the subject of hæmophilia. The small wound became the seat of almost uncontrollable hæmorrhage, and it was not until a fortnight had elapsed that the patient could be said to be out of danger. In another case, I removed—at the patient's urgent request—a small sebaceous cyst from the scalp of a man of fifty. The wound soon broke down, suppurated freely, and became the starting-point of a low form of erysipelas, of which the patient nearly died. It was discovered after the operation that the man was suffering from diabetes, a fact of which he himself was not aware.

In forming a proper estimate of the risks involved by operations—so far as the condition of the patient is concerned—many factors have to be considered, and in the paragraphs which follow the more important are dealt with.*

Age.—Age exercises a considerable effect upon the result of operations.

In *children* wounds usually heal well; the patient's organs are healthy and vigorous, and the nutritive activity of the body is in its prime. Children show great recuperative power, and are free from the effects of that mental anxiety which often acts so injuriously upon adults. They are able, moreover, to

* Considerable use has been made of Sir James Paget's classical lecture upon the subject. The question of the effect of the operation itself is alone considered. The special risks attending the administration of anæsthetics and the circumstances modifying those risks must be left for discussion in special works on the subject.

stand long confinement in bed, and even to endure a tedious suppuration with comparatively little ill effect.

On the other hand, children suffer severely from shock and the effects of acute pain. Pain, if unrelieved, may in a few hours reduce a child to a state of collapse. Mr. Howard Marsh cites the case of a child, two years old, who "died apparently of the pain and terror caused by the repeated dressings of a burn on the trunk and lower limbs."

Shock is certainly a prominent danger in operations upon young and healthy children. Abdominal section for the unravelling of an intussusception is an operation frequently required in infants and young children. Since surgeons realised the importance of all possible rapidity and protection against shock in such operations the mortality has greatly diminished.

It has been said that children bear the loss of blood badly. Mr. Marsh has questioned the soundness of this belief, and with his view I entirely concur. Hæmorrhage must be regarded relatively when comparing children with adults. If the weight of the body be taken in conjunction with the amount of blood lost, I think it will be found that children bear hæmorrhage well, and, in the case of repeated bleedings, often remarkably well.

Operations should not be performed, if possible, during the first dentition. Children are then often restless and excitable, liable to digestive disturbances and to convulsions, and apt to develop a high temperature under little provocation.

The natural restlessness of children is often an obstacle to the perfect success of an operation, and operations in the region of the pelvis are apt to be complicated by the difficulty of keeping the child clean. This is of special importance with regard to operations for radical cure of hernia, which in young children require the greatest care to prevent soiling of the wound with urine, and consequent suppuration.

It is essential to the good result of a plastic operation that the child should be in sound health. The operation should be postponed if the patient has recently been exposed to the risk

of infection from any of the exanthemata, or is the subject of diarrhœa or any gastric disturbance to which young children are so liable.

The remarkable effect an operation now and then appears to have in determining the appearance of scarlet fever is well known.

Of the influence of *old age* upon operations, Sir James Paget writes :—"Among the old there are even greater differences than among the younger in the ability to recover from operations; and age, if reckoned by years, is not the only thing in them we must estimate. . . . They that are fat and bloated, pale, with soft textures, flabby, torpid, wheezy, incapable of exercise, looking older than their years, are very bad. They that are fat, florid, and plethoric, firm-skinned, and with good muscular power, clear-headed, and willing to work like younger men, are not, indeed, good subjects for operations yet they are scarcely bad. The old people that are thin and dry and tough, clear-voiced and bright-eyed, with good stomachs and strong wills, muscular and active, are not bad; they bear all but the largest operations very well. But very bad are they who, looking somewhat like these, are feeble and soft-skinned, with little pulses, bad appetites, and weak digestive power, so that they cannot, in an emergency, be well nourished.

"The old are, much more than others, liable to die of shock, or of mere exhaustion within a few days after the operation. They bear badly large losses of blood, long exposure to cold, sudden lowering of temperature, loss of food. Large wounds heal in them lazily. Their stomachs, too, are apt to knock up with what may seem to be no more than necessary food—though, indeed, it often is so; for many old people are in less peril with a scanty diet than with a full one. Their convalescence is often prolonged. . . . There are some to whom convalescence is more dangerous than disease.

"You must choose for the old, if you can, short and gentle operations, and be sparing of hæmorrhage. You must keep them warm, and not feed them beyond their real necessities,

nor keep them long recumbent. In all their convalescence you must be constantly on the watch for latent mischief. Your cares must be doubled when your operations are on the lower limbs, or the lower part of the trunk, or on the back, for in operations on these parts the risks, both local and general, are much greater than in the parts above the heart. . . . Let me add that of all the conditions of disease or imperfect health which influence the results of operation, there is no graver complication than old age, unless, indeed, it be habitual intemperance."

Sir James Paget's picture is perhaps too highly coloured. It is not old age so much as senile degeneration that is to be feared by the operating surgeon. In well-preserved patients over seventy, excellent recovery may be witnessed after ovariotomy, herniotomy, or other major operations. Few procedures would appear more formidable than suprapubic prostatectomy, which involves considerable bleeding, a somewhat rough operation, and the persistence of a urinary fistula for some weeks. Yet the mortality of this operation, performed on patients of from fifty to eighty years of age, is not more than ten per cent.

Sex.—Other things being equal, it would appear from statistics that women bear operations somewhat better than men. This fact may be explained by the circumstance that they are more tolerant of confinement to house and bed, lead less active lives, and adapt themselves more easily to the surroundings of an operation ward. They are probably more temperate and regular in their lives, and owe not a little to a certain natural determination and patience.

It is well not to operate, unless compelled, during menstruation. In perhaps the larger number of instances of operations performed during this period no ill effects are noticeable. Indeed, we have performed not a few abdominal operations of an urgent character during menstruation without noting any ill consequences; in some so dealt with an unaccountable rise of temperature, often with considerable nervous and digestive disturbances, is met with. The operation may hasten by several

days the appearance of the natural menstrual period, and it may then be attended by unusual symptoms of excitement and of general irritation.

Still more desirable is it that no operation should be performed during pregnancy. The special risk incurred in such a case is that attending abortion. Apart from this risk there is little to anticipate, and wounds do well. Ovariotomy and other grave abdominal operations have been performed during the various stages of pregnancy without inducing abortion and without evil results. It appears to be impossible to estimate the chances of miscarriage after any surgical procedure. One of the most remarkable recoveries I (J. H.) have known from an operation during pregnancy was that of a young woman who, during the eighth month, was seized with true gangrenous appendicitis and diffuse peritonitis. After excision of the appendix and free drainage, etc., she recovered, and bore a living child a month later.

During lactation, also, operations should be avoided when possible; the patient is usually in comparatively feeble health, and certainly not in the best condition for a serious call upon the nutritive powers. Operations performed during lactation have, however, done well enough, with the emphatic exception of operations upon the breast. Fatal hæmorrhage has in more than one recorded case followed an incision made into the active mamma.

The Robust and the Feeble.—Experience shows that the best subject for an operation is not the strong, lusty man in the prime of life. He may have mighty limbs, and immense strength and endurance. He may boast that he has never had an ache or pain in his life, and that "he can stand anything." He may lay claim to the possession of what is popularly known as "the constitution of an ox"; but the surgeon's knife is at least one thing he can meet but indifferently. He will probably not bear an amputation so well as some pale, puny individual of the same age, who is feeble and wasted, and who has been laid up for months with disease of a joint.

The strong man has his mood of life suddenly interrupted. His blood-vessels are full; his viscera have adapted themselves to the exigencies of an active life; his tissue-changes are rapid and extensive, oxygenation is quickly disposing of the great refuse matter which is continually accumulating at the very moment when the tide is abruptly checked. The man finds himself motionless in bed; every circumstance of his life is changed; he has had no time to adapt himself to his altered position, and it is a matter of little wonder that the inflammatory process which has been induced runs riot and is not readily controlled. Circumstances are not improved by his altered mental condition, by the shock of his accident, the horror of the mutilation, the possible miseries of the future.

The subject of joint disease is, on the other hand, acclimatised to bed-life; his diet, his muscular changes, his breathing powers, have all adjusted themselves to the molluscous condition. His viscera are healthy, there is no accumulation of *débris* to be rid of, and possibly even confinement is ceasing to be irksome. To such an individual amputation comes as a relief. He has been wearied of continued pain and inefficient treatment, and the change that amputation brings in his life is agreeable, and opens up the prospects of a new existence. It rids him of a burden that may have become intolerable.

The difference in the mortality of amputations for injury and for disease may serve to emphasise this point. It must be distinctly understood, however, that these differences are only partly due to the patient's condition. They perhaps as largely depend upon the circumstances of the amputation, which must of necessity be uncertain in operations for injury where it is difficult to ascertain the limit of the sound tissues. Not a little also depends upon the completeness of the aseptic precautions.

A small operation upon a healthy man—such a one as will but little, if at all, interfere with his daily mode of life—may be expected to do well in any case; but if the procedure be more extensive, and involve absolute confinement, it is as well

that the patient should prepare himself by a few days in bed, and by a modified diet. The preliminary rest of a week in a hospital ward before an operation may have considerable effect upon the issues of the procedure in the case of a labouring man fresh from his work. In few, if any, instances can it be desirable to perform an operation of expediency of any magnitude upon a patient within a few hours of admission to the hospital.

The great importance of allowing sufficient time for thorough disinfection and cleansing of the skin prior to operation can hardly be emphasised too strongly. For example, it is never wise to operate on a fractured patella within a day or two of the injury. Complete rest of the limb on a splint for several days and repeated cleansing of the skin over the joint with antiseptics should always precede the operation. Further, the preliminary purgation, which is now a routine practice, is essential in many cases, and useful in all. An operation for hæmorrhoids, undertaken without due preparation on a patient given to high living, is only too apt to be followed by disaster.

Obesity and Plethora.—The very corpulent are certainly not good subjects for operation. In some of them operations do quite well. These will probably be young persons in whom the disposition to corpulence is hereditary, who are in sound health, and take every reasonable means to prevent increase of weight.

All obese individuals about or beyond middle life are, as a rule, bad subjects for operations, and more especially the men. The excessive corpulence may have been induced by gluttony or drinking habits, or have been encouraged by indolence or disease. These patients often breathe with difficulty, and cannot assume the entirely recumbent position. They soon become helpless; their mere bulk renders it difficult for them to be moved in bed and for dressings to be applied; their skin is frequently unwholesome, and they are not readily kept clean.

The integuments through which the wound is made—in any case involving a surface incision—are thinned, anæmic, and flabby. The edges of the wound come ill together. The immense layer of subcutaneous fat is indifferently supplied with blood, and has possibly been damaged during the operation. Portions of this tissue have been broken up and isolated from a blood supply. Indeed, in sponging these wounds before the sutures are inserted, a quantity of such isolated tissue may come away with the sponge. The thickness of the parts involves much strain upon the sutures. If, after the operation, the patient incline towards the affected side, the whole wound region becbmes pendulous, drainage is difficult in instances in which suppuration is present, and the application of pressure in the dressing of the incision is almost impossible. If the wound become infected, a low type of inflammation is apt to develop. Such patients often die almost suddenly; others become soon exhausted, or succumb to an intercurrent disease. The most favourable make but a tardy recovery.

Plethora, as a simple condition, does not compromise the success of an operation. Indeed, the "full-blooded" pass through a surgical experience well enough, provided that the plethora depend upon no diseased condition. This ruddy-cheeked, clear-eyed, and firm-limbed individual must, however, be distinguished from the florid and bloated counterfeit so often represented by a brewer's drayman or a jovial innkeeper.

Alcoholism.—A worse subject for an operation can scarcely be found than is provided by the habitual drunkard. He seems to be readily susceptible to septic infection and his tissues to the spread of such infection.

The condition contra-indicates any but the most necessary and urgent procedures, such as amputation for severe crush, herniotomy, and the like. The mortality of these operations among alcoholics is, it is needless to say, high.

Many individuals who state that they "do not drink," and who, although perhaps never drunk, are yet always taking a little stimulant in the form of "nips" and an "occasional glass,"

are often as bad subjects for surgical treatment as are the acknowledged drunkards.

Of the secret drinker the surgeon has to be indeed aware. In his account of the "Calamities of Surgery," Sir James Paget mentions the case of a "person who was a drunkard on the sly, and yet not so much on the sly but that it was well known to his more intimate friends. His habits were not asked after, and one of his fingers was removed because joint disease had spoiled it. He died in a week or ten days, with spreading cellular inflammation, such as was far from unlikely to occur in an habitual drunkard." This case, of course, falls into the period prior to the introduction of antiseptics in operations.

Even abstinence from alcohol for a week or two before an operation does not always greatly modify the result.

An operation performed upon an habitual or occasional drunkard is apt to be followed by an outburst of delirium tremens, a complication that brings a very greatly increased risk to a patient already in no little danger. It must not be assumed that an operation upon a subject of alcoholism must of necessity turn out badly. The evil result is, however, sufficiently frequent to justify a refusal to perform any but urgent operations, and the occasional fact that grave operation wounds in heavy drinkers may heal kindly and well is rather an illustration of good fortune than of surgical success.

Tuberculosis.—On the whole, it may be said that tuberculous patients stand operations remarkably well, and this especially applies to tuberculous children. In a large proportion of the cases, the operation rids the patient of a long-abiding trouble, and a source of persistent irritation and weakness. It is sometimes surprising to note how a pale, wasted, cachectic-looking child, as wan as a shadow, will improve and gain in flesh and in looks almost directly after such an operation as amputation of the leg for the removal of a wholly carious foot. Some of the best examples of amputation at the hip-joint—so far as speedy recovery is concerned—have been met with among tuberculous children.

It must be assumed that in these and in other cases there is freedom from serious visceral disease, such as lardaceous degeneration of the liver.

Operations upon the tuberculous are remarkably affected by their surroundings. The patient requires unlimited fresh air and the most favourable hygienic conditions. Results may be obtained at the seaside which can hardly be expected in the crowded wards of a city hospital. In any case—and especially when operating in large towns—the after-treatment of the case should be hastened as far as is possible, and the patient be removed from bed and allowed to get into fresh air as soon as can be managed.

The operation wounds in these patients—taking the operation for the removal of caseous or broken-down glands as an example—usually do well at first, often remarkably well. They heal up in large part, then the healing process not unfrequently halts, pus is found to be formed in the depths of the wound, a sinus is apt to persist, or the scar remains weak, or takes on the character of a tuberculous ulcer.

Often enough this disappointment, in what seemed at first to be a speedy healing by first intention, is due to an imperfect removal of the original disease; but it is not always the case. A like result may follow an amputation through healthy parts.

The tuberculous patient has little power of sound plastic repair. Healing may be rapid, but it is not always substantial. The scar building in the tuberculous is a little comparable to the work of the "jerry-builder." As Verneuil well says, operations upon the tuberculous abound in "half successes, incomplete results, and unfinished cures."

The success of an operation upon these patients must be judged three months after its performance.

The result can be greatly influenced by the selection of proper cases, by the complete removal of every atom of diseased tissue in the operation area, by taking every step to secure primary healing and to avoid any risk of infection, and by

placing the patient at as early a period as possible in a fresh atmosphere.

It is claimed by the advocates of the "opsonic system" of treatment that the carefully adjusted injection of tuberculin into the circulation may prevent the necessity for operation or may shorten convalescence after it has been performed. At present these claims rest mainly on assertion. Of far greater importance is it to secure the best conditions of diet and general hygiene for these delicate patients. The increase of late years in the number of well-managed convalescent homes at the seaside and in the country—to which cases with wounds not fully healed may be admitted—has been of the greatest service, though much still remains to be done in this direction.

With regard to operations upon the subjects of *phthisis*, one must distinguish between the acute and chronic forms. In both, however, there is a special danger attending the use of an anæsthetic, especially if the operation must be a prolonged one. All surgeons will agree with Sir James Paget that any kind of operation should be avoided if possible on the subjects of acute or rapidly progressing consumption.

"The case is very different with chronic or suspended phthisis. In these it is often advisable to incur the somewhat increased risk of even a large operation, in order to free the patient from the distress and wasting of a considerable local disease, such as that of a joint; and I should be disposed to say that it is always advisable to cure, if you can, a small disease, such as a fistula. I say if you can, for you will often be disappointed. In the tuberculous, your wounds will remain for weeks unhealed, and perhaps be unsoundly healed at last. Still, as to the mere question of operating, I have seen so many advantages accrue to patients with chronic phthisis from the removal of limbs with joint disease, that I am disposed to speak strongly as to the general propriety of whatever operations they may reasonably require." There is no doubt also that in operations upon the phthisical, disease in the lung may be

temporarily aggravated by the anæsthetic, especially if it be ether.

Syphilis.—In the great majority of cases syphilis does not injuriously affect the course of an operation, and is no bar to such a measure. If the patient be rendered cachectic, or be the subject of visceral disease, he is placed in the same unfavourable category with those who are similarly affected from other causes. Wounds made during the progress of secondary syphilis more often heal well than show any evil tendency; occasionally they become the seat of a transient syphilitic manifestation, and heal indifferently, or break down after a speedy closure. Such an event may occur without the appearance of any distinct syphilitic change in the part. The same may be said of operations performed late in syphilis, or many years after its occurrence. They usually do well. In the minority of the cases, however, primary healing is not secured, or the wound heals and breaks down again, or remains open, and becomes the seat of a dull, persisting suppuration, or of an ulcer possessed of specific characters. This, perhaps, more often happens when the incision involves tissues which have been previously damaged by syphilitic disease. Thus it comes to pass that plastic operations not unfrequently fail in syphilitic persons, especially when performed for the relief of deformities produced by some destructive manifestation of the disease. Such operations should not be lightly undertaken, nor carried out until every means, both by general and specific treatment, has been taken to place the patient in the best condition of health. A typical instance is afforded by perforation of the hard palate from tertiary syphilis. Such cases are hardly ever worth operating on, though the poor result which follows may be largely due to the condition of the tissues around.

Rheumatism and Gout have practically no effect upon the immediate future of an operation. The wound heals kindly and well. It is unnecessary to say that an operation should, if possible, not be performed during an outbreak of either of these conditions. It must be remembered, also, that any of

the sequelæ of rheumatism or gout may complicate the issues of an operation. Such are the cardiac changes so often attendant upon the former disease, and the degenerations of the kidneys and other viscera which are apt in course of time to follow upon the latter.

An operation not unfrequently determines an attack of gout, but such attack usually has no noteworthy effect upon the progress of the wound.

Cancer does not render a patient a bad subject for operation. The result of the operation may be modified by other conditions, such as the age and temperament of the subject, and the presence of visceral disease. Cancer, as such, appears to exercise no effect upon the healing process. Indeed, operations for the removal of malignant growths in old and broken-down individuals usually do remarkably well.

Anæmia, especially when due to loss of blood, has no special effect upon a surgical wound. The healing may be slow; the patient is perhaps rendered unduly liable to bacterial infection, and has little power to meet such misfortune. It is most important that before an operation of expediency be performed, the anæmic condition should be dealt with by proper treatment.

A warning may here be given as to the risk of operating on those who are living and working in hospitals—nurses, house surgeons, and others—without preparing the patient by a week or two's rest and fresh air. This applies to the major but not urgent operations which have occasionally to be performed on hospital nurses, etc. Of course many minor but urgent operations have to be done on them without such preparation.

Leucocythæmia has a disastrous influence upon operation wounds. Splenectomy, although performed many times in the subjects of leucocythæmia, has been followed by one uniform result—all the patients have died.

Serious, if not fatal, results have followed in less grave procedures, and in the leucocythæmic person even a trivial operation is dangerous. They stand in peril of hæmorrhage, and become the ready subjects of septic infection.

Hæmophilia forbids a surgical operation of any but the most pressing kind. If the operation proposed be urgent and required to save life, and if the risk involved by the disease or injury be clearly greater than that which may attend a wound in a "bleeder," it is obvious that the operation should be carried out. Thus, an incision for the relief of strangulated hernia, after attempts at reduction have failed, is justifiable. The subjects of hæmophilia do not always bleed desperately after a wound; perhaps the most certain hæmorrhage will occur after an operation upon the mouth. Still, a member of a "bleeder family," who has nearly bled to death from a slight accidental cut of the lip, may undergo an amputation of the foot with no more than the usual loss of blood.

Scurvy must stand, so far as operations are concerned, in the same position as hæmophilia. Apart from the risk of hæmorrhage which follows an operation performed during an attack of scurvy, there are the further dangers attending a wound which does not heal, which ulcerates and leads to interminable suppuration.

Acute Diseases.—It is needless to say that no operation, except such as is so urgent as to be necessary to save life, should be performed during the progress of any acute disease, such as pneumonia, an eruptive fever, and the like.

The same may be said of erysipelas. Incisions have to be made in the course of that disease to relieve tension and to evacuate pus, but they cannot rank as operative measures. If an amputation is rendered necessary in a subject of erysipelas, the less danger would attend the postponement of the operation until the acute period of the infection had passed.

It is most important to avoid, when possible, any operation upon inflamed parts. This applies as well to so small an operation as the removal of a pile as to the excision of a large tumour. With operations in the present sense are not classed such surgical measures as are employed for the relief of inflammation or the opening of abscesses.

It may be here remarked, also, that a good and fine cicatrix

cannot be expected if the margins of the wound are formed of tissues which were inflamed when the incision was made. This is well illustrated by operations upon the neck for gland disease, in which it is a point that the resulting scar should be as insignificant as possible.

Affections of the Nervous System.—The mental state of a healthy patient, as expressed by the terms "nervous," "neurotic," "excitable," "apathetic," has little definite effect upon the result of an operation. The very nervous individual, who approaches the operation with bated breath, who discusses it with a fluttering vivacity, and is haunted by exaggerated forebodings, usually does well enough. After the operation is over, her imagination probably enters upon a new field; she conceives and prophesies a speedy recovery, and often assumes the *rôle* of the unusually hopeful and courageous patient.

The least favourable frame of mind is that marked by gloom and utter apathy, and by a morbid stoical indifference, difficult to dispose of. It is illustrated by the dull-faced woman whose conversation smacks of "Meditations among the Tombs"; and by the sullen man who meets a cheery account of the hopeful prospects of his operation by the remark that "he is ready to go."

Possibly the most favourable nerve conditions are met with among healthy young men, who sleep well, take whatever happens as a matter of course, make few inquiries, and meet all circumstances in the spirit of Mark Tapley.

Operations upon *hysterical* or *epileptic* patients are apt to be complicated in their after-treatment by outbreaks of the nerve affection. While attacks of both hysteria and epilepsy are clearly often induced by an operation, on the other hand a precisely opposite effect may follow the surgical measure.

An operation on an hysterical patient which is performed solely with the intent of influencing the mental condition is both useless and unjustifiable. Even if temporary improvement follows, the malady or neurosis always returns. This warning cannot be urged too strongly.

The *insane* bear operations unusually well, provided that certain conditions are present. They must be in sound health, amenable to treatment, and of cleanly habits. The regular life of an asylum is conducive to a state of health very well adapted to meet the strain of an operation; and the absence of mental anxiety in the patient is another favourable feature. In many subjects of chronic mania, of melancholia, and of dementia, the general health is quite broken down, and, as a consequence, they are not good subjects for any operative treatment. In those of the insane, also, who are violent, restless, mischievous, or of very dirty habits, the success of the operation may be so far frustrated by the patient that its performance becomes a matter of question.

In not a few instances, insanity appears to have been induced by operation. The patients are generally women, and the operation, for the most part, one concerning the breast or pelvic organs. The occurrence of this unfortunate circumstance is neither frequent enough nor sufficiently well defined to influence a surgeon in the performance of a necessary operation. In men insanity has several times followed castration, especially when the testicles have been normal, as in the operation formerly practised by some in the treatment of enlarged prostate.

Diabetes.—In a diabetic subject the tissues appear to offer the most favourable soil for the development of putrefactive bacteria. The subjects of diabetes are especially prone both to peripheral neuritis and to degenerative changes in their arterial walls. Gangrene of a terminal portion of a limb may in them be associated with vascular disease extending a long way above the area directly involved. When to these considerations is added the possible risk of diabetic coma, it will be understood that formerly any operation on such patients was regarded with the gravest concern.

Careful dieting directed against the diabetes is, however, sometimes successful in averting the necessity for an operation (*e.g.* when perforating ulcer and cellulitis of one foot has led the

surgeon to propose amputation). Moreover, recent experience has shown that such preliminary regimen and thorough aseptic precautions make the prognosis of a major operation on a diabetic subject less gloomy than has been stated above. Much will depend on the state of the patient's arteries, and his improvement under suitable regimen—shown by the diminution or disappearance of the sugar and acetone from the urine. There is, however, always a special risk in giving anæsthetics to diabetic subjects.

The subject of amputation for diabetic gangrene is dealt with in a most able paper by Mr. Rickman Godlee (*Med.-Chir. Trans.*, 1893, page 37). He shows that when the gangrene is associated with peripheral neuritis an operation may be frequently avoided, or, if required, it need not be performed at a great distance from the seat of the disease. On the other hand, if there is evidence of extensive arterial degeneration, a high amputation (*e.g.* above the knee for gangrene of the foot) must be done; and with the precautions mentioned above a good result may be anticipated.

Visceral Disease.—(1). *Heart Disease and Atheroma.*—In the matter of heart affections, it may be said that the patient whose heart is feeble, or fatty, or embarrassed by valvular disease, is exposed to extraordinary risk from the shock of an operation; but apart from this, heart disease, if it has induced no wide-spreading tissue change, appears to add little to the danger of the undertaking. On the other hand, as Verneuil points out, valvular lesions and degeneration of the muscular tissue of the heart may, by changing the conditions of the entire circulation, cause impairment of the viscera, alter the tissues, and bring about a condition very unfavourable to the healing process. Such patients show a disposition to passive hæmorrhages—difficult to check, together with œdema of the wounded region, and there is no doubt that their tissues are particularly predisposed to bacterial invasion. We have known cases in which ulcerative endocarditis—in a latent condition and previously unsuspected—has after an operation led to a fatal ending.

Operations are often performed upon limbs the arteries of which are affected by atheroma. It is surprising how well ligatures maintain a hold upon such vessels, and how well these remain closed. The risk that would appear to be most pressing, that of secondary hæmorrhage, is in actual practice very rare. That wounds in such subjects are more liable to secondary bleedings than are wounds involving parts supplied by normal arteries is probably true, but the occurrence is not frequent. The real risks in these cases are from gangrene, from sloughing of the flaps of an amputation, or the breaking down of the simplest incision, and from diffuse inflammations of a low type.

(2). *Lung Disease.*—The relation of phthisis to the results of an operation has been already considered. Any chronic lung affection, such as chronic bronchitis, usually indicates impaired health, and offers difficulties in the after-treatment on account of the embarrassed breathing, the disturbance of parts produced by coughing, and the imperfect oxygenation of the blood. Operations on such individuals can hardly be expected to follow an even course. This question is of particular interest with regard to operations for radical cure of hernia after middle age. The chronic bronchitis which has caused the hernia to develop may be itself a sufficient reason against the surgeon operating for its cure.

(3). *Affections of the Alimentary Canal.*—In the matter of affections of the alimentary canal there is little to be said. The effect that any disease of the stomach or intestines may have upon an operation is to be measured by the effect it has upon the general health. The subject of chronic dyspepsia can hardly be well nourished, and the subject of habitual constipation is burdened with a trouble which an operation serves to complicate. It is unnecessary to state that an operation should be avoided during the course of diarrhœa or dysentery, and should not be undertaken until the patient has well recovered from the trouble.

The "auto-intoxication" of sufferers from chronic and

acute intestinal obstruction, or from septic peritonitis, accounts for the grave prognosis of operations for their relief. It is not the operation that causes death, but the state of poisoning which had pre-existed.

(4). *Diseases of the Liver.*—Affections of the liver have an injurious influence upon operations, an influence which is peculiar and pronounced.

"You should be cautious," writes Sir James Paget, "in operations upon those whose biliary secretions are habitually unhealthy; those who have been often jaundiced; or those who bear that sallow, dusky complexion, with dry skin, and dilated small blood-vessels of the face, and sallow, blood-shot conjunctiva, which commonly tells of what is supposed to be an 'inactive liver.' Many of this last class are not temperate; many are sedentary and indolent; many suffer habitually from hæmorrhoids; probably all have some abdominal plethora; probably, in all, their digestive organs act as ill as their skins do. But, whatever we may guess to be the special defect of these organs, you need not doubt that operations upon those who have them are attended with more than the average risk; and that when you are obliged to operate, you must do so with more than ordinary care and caution."

On the other hand, few major operations, taken as a whole, are more successful than those for cholelithiasis, whether jaundice has been present or not. But here the cause of the liver trouble can be removed by the operation.

The more defined diseases of the liver have a definite ill effect upon surgical wounds. These are cirrhosis of the liver and the conditions of fatty or amyloid degeneration. Advanced forms of these affections offer an almost absolute bar to operation. The subject of cirrhosis is probably a drunkard; the subject of amyloid degeneration, the victim of long-continued suppuration.

The risks these patients run are numerous: some succumb to shock, others die of exhaustion. In all there is a special risk of septic infection, and a probability that the wound will

not heal, but that it will slough and suppurate, and become the seat of spreading inflammation of a low type.

When an operation, such as abdominal section, has to be performed on a jaundiced patient, it is possible that the risk of persistent hæmorrhage may be diminished by giving drachm doses of chloride of calcium during the few days immediately before the operation. This practice is advocated by Mr. Mayo Robson. We have not been able to convince ourselves of its value.

No question is more difficult to decide than that which concerns the period in the progress of lardaceous disease of the liver beyond which it is practically unjustifiable to operate.

In the advanced stages of the disease a serious operation is hardly justifiable. In the earlier periods an operation, such as an amputation, may be performed with admirable success, for it not only rids the patient of his trouble—probably a suppurating joint, with adjacent necrosed bone—but it removes the cause of the visceral complication.

(5). *Kidney Disease.*—It may be safely said that the results of operations are more powerfully influenced by diseases of the kidneys than by a corresponding disease of any other organ. An operation upon the subject of Bright's disease, or of surgical kidney, is a grave matter. A patient may look fairly healthy, may appear well nourished, may be temperate and living a most regular life, and the operation may be but a trifling one, yet the complication of albuminuria renders the surgical procedure undoubtedly hazardous. Many an elderly man has died almost suddenly from the effects of rough catheterisation, and it has been found after death that he was the subject of an unsuspected pyelitis.

Quite slight operations, of no urgency, such as that for the relief of Dupuytren's contraction of the palmar fascia, have placed the subjects of Bright's disease in great danger of death.

In no case should an operation on an adult be undertaken without a preliminary examination of the urine. Almost every surgeon must have met with instances in which the neglect of this precaution has led to unfortunate results.

It is impossible to define the particular power for evil each individual affection of the kidney has upon a surgeon's work. It is sufficient to know that the existence of pus or sugar or albumen in the urine places a patient within the very narrowest sphere of operative possibilities. It is true that in some instances—as in a form of albuminuria met with in connection with large abdominal tumours—the existence of the albumen is no bar to an operation; it is true also that patients with Bright's disease have now and then recovered admirably from large operations. The fact remains that organic disease of the kidney is one of the most serious complications with which the operator can be concerned.

Stone in the kidney may be wholly unsuspected before operation, and may have caused such renal disorganisation as to imperil the result. I (J. H.) removed a large ovarian tumour with twisted pedicle; a fortnight later the patient developed uræmic symptoms and died; calculi were found in each kidney. About the same time a colleague performed ventrifixation of the uterus on account of cystitis in a woman; she died a day or two later, and a calculus was found plugging each ureter. The possible existence of latent renal calculi is apt to escape attention, and it is unfortunate that radiography will not always reveal them when they are present and have been suspected.

The subjects of kidney disease exhibit nearly the same evil tendencies after operation as have been alluded to in dealing with hepatic troubles. They are exposed to the additional risk of death from suppression of urine and uræmia. Such patients often die of exhaustion many days, or even a week or more, after the operation. They are especially prone to septic infection, and consequently to all the evils incident to wounds. Primary healing cannot always be depended upon.

It is possible, however, in many cases to improve the condition of the urine by preliminary treatment before the necessary operation. Urotropine, salol, cystamine, and allied drugs have a marked effect in diminishing bacteria in the urinary tract. As a rule, no cutting operation on kidneys, bladder, or urethra

should be performed on a patient with septic urine until a careful trial has been made of the above, combined with rest in bed, light diet, and aperients.

When pyæmia was common in hospital wards, the subject of kidney disease became its readiest victim. Surgeons have learnt how to ward off pyæmia, but they have yet to learn how to meet the complication of Bright's disease.

2.—PREPARATION OF THE PATIENT

Period before the Operation.—It will be evident, from what has been already written, that the most thorough examination possible of the patient should be made before an operation is undertaken.

To carry this out, it is well that the individual should be under observation for some little time before he appears in the operating room.

In the case of those who have been long confined to bed, it is obvious that the sooner they are relieved the better.

On the other hand, in the matter of operations of expediency upon patients who may be termed healthy, it is well that they should pass through a period of rest before the operation is performed. Operations hurriedly undertaken are not unfrequently regretted.

In hospital practice it is better not to operate upon a man who comes straight to the wards from some active outdoor work, who is robust and has been living heartily, and who has still the vigorous throb of exercise in his blood and in his limbs. The practice is frequent, for the operation has been previously arranged, and the man does not want to lose even a few hours' work.

Such a patient is placed in an infinitely better condition by a few days' rest in a hospital ward. He here becomes accustomed to his surroundings; he has time to be rid of the refuse matter in his tissues, which can no longer be cast off by muscular exertion; his hearty appetite is enabled to adapt

itself to his present requirements; the excreta can be dealt with; and time is allowed to make the skin as nearly aseptic as possible.

To all the organs, to the still strongly-beating heart, and to the over-worked muscles, there is allowed a period of repose. When the operation day arrives the patient has become acclimatised, strict confinement to bed and a limited diet do not involve so very sudden a change, he has adjusted himself to his new environment, and the ordeal is met after a period of physiological rest.

Many small operations would do better if the patient would consent to the preliminary of a few days' rest. This is conspicuous often in operations upon piles, when the subject persists in absorbing himself with his work up to the time of the operation. Often a business man will overwork himself desperately before his operation, in order that his affairs may not suffer in his absence.

What is worth doing at all is worth doing well, and not a few operations, the performance of and recovery from which have to be compressed within a few hurried days, had better not have been performed at all.

Diet.—The practice of starving a patient before an operation is undoubtedly unwise. The amount of the food should be suited to the condition of an individual who is inert and within doors. It should be nutritious, but small in bulk, and not of a character to leave much *débris* in the intestine. Entire abstinence from alcohol for a week or more before an operation might prove very judicious in not a few instances. The patient who "keeps himself up" by spirits before an operation is preparing for himself a sore down-going after the event is over.

The Bowels.—The bowels should be well opened on the eve of the operation; and this is best effected by an aperient overnight and an enema in the morning.

The Preparation of the Skin.—Care should be taken that the patient's body is clean. This is a surgical necessity of the utmost importance. A warm bath on the night before

the operation is desirable whenever possible, and a source of comfort to the patient. If time permits, the operation area should be repeatedly washed for some days before the operation.

Some hours before the patient is brought to the theatre the skin of the operation area should be specially treated with the view of removing or rendering harmless the ubiquitous micrococci. The following is one of many plans followed :—

(1). If a hairy part, the skin should be carefully shaved.

(2). With soap and hot water a thorough mechanical cleansing should be carried out. This, however, will not destroy germs in the epidermis or remove fatty matter.

(3). The skin is now thoroughly cleansed with ether to remove fatty matter and epithelial *débris*, and is again washed with soap and water. Sterilised nail-brushes should be used if possible, though where the skin is tender or thin this cannot be done.

(4). With gauze or wool sponges soaked in an alcoholic solution of carbolic acid (1 in 20), or bichloride of mercury or mercuric potassium iodide (1 in 500), the part is rendered really aseptic. A mixture of 1 in 20 carbolic acid and 1 in 500 bichloride of mercury is very efficient, but the solution must be made with alcohol and not with water. The mercuric potassium iodide solution (1 in 500 in rectified or methylated spirit) has many advantages. It is very easily prepared. It is less toxic than corrosive sublimate ; it does not corrode plated instruments, and it neither roughens nor irritates the skin. Its germicidal powers are equal to those of corrosive sublimate.

(5). Moist, sterilised gauze or lint (soaked in a 1 in 60 solution of carbolic acid) should then be applied under waterproof tissue, bandaged on, and not touched until the patient is on the operating table. It is easy to attach undue importance to this antiseptic compress. It merely protects the part, and so macerates the skin that the surface epithelium can be rubbed off at the last moment.

Aqueous solutions are practically powerless against organisms in the epidermis.

(6). When the compress is removed, immediately before the actual incision is made, the assistant should invariably go over the area again with ether and with the alcoholic solution mentioned above. Finally, the skin is wiped dry with sterile swabs. In certain regions, such as the scrotum or eyelids, these strong antiseptics cannot be used, and it may be said that it is impossible to render the scrotum really aseptic. The axilla is also a most difficult region to make surgically clean.

Clothing.—The body should be well and warmly clad during an operation. Not a little of the shock that sometimes follows a long operation may be due to the fact that the patient has been lying nearly naked upon a table, for an hour or more, possibly in a cold room, and exposed to the further chilling action of wet applications. This precaution applies especially to old persons and to the winter time. In the best modern operating theatres (*e.g.* those at the London Hospital) warm, pure air can be rapidly introduced so as to raise the temperature of the room quickly to 75° or more before an important operation. Moreover, during cold weather and in theatres inefficiently warmed an operating table may be used which is capable of being artificially warmed by means of hot water. In the case of infants, the patient should lie on a hot-water cushion, duly protected, during the operation.

The night-dress to be worn after the operation should be divided down the back, so that it may be removed without disturbing the patient. The form of flannel jacket called by nurses a "nightingale" is very useful, especially for patients who can sit up in bed.

In the case of women with long hair, the various coils and twists should be undone, the whole hair parted behind in the median line and disposed of in two simple lateral plaits. The hair is thus kept out of the way—should the operation concern the head and neck—and after the operation the head

can rest comfortably upon the natural scalp, and not upon a complicated mound of wisps of hair, hair-pins, and other foreign substances.

The Hour for the Operation.—The most convenient time for an operation is the early morning, say between eight and ten a.m. As the patient should have no food for five hours before he is anæsthetised, this appointment involves the omission of no meal but breakfast. If he has slept well, there is little time between his sleep and the surgeon's coming in which to ruminate and to foster an alarm. Should any serious complication occur within a few hours of the operation, it will be daylight, and prompt assistance will probably be at hand.

The above observations apply to the preparing of a patient for an operation of some magnitude. They apply in proportionate degree to procedures of lesser gravity. For certain measures special preparations have to be made. These are described in the sections which deal with such measures.

CHAPTER II

THE OPERATOR

THE surgeon, according to the oft-quoted axiom of Celsus, should be young. By this it is to be inferred that he should be possessed of the muscular strength, the courage, the sureness of hand and the keenness of eye, which are assumed to be the qualities of youth.

Operative surgery is a *handicraft*, and the accomplished operator must lay claim to be considered a skilled handicraftsman. Like other and simpler handicrafts, much in the attainment of success depends upon natural aptitude and physical qualification; but still more depends upon culture and patient practice. A well-matured and well-balanced judgment guides the hand of him who shows most skill; he may do well who is bold, but he will do better who has precise knowledge. The surest sense of confidence rests with the operator who knows accurately what he intends to do, and how to do it. The least success follows the hand of the man who retains throughout an operation a speculative spirit, who depends largely upon his imagination for conditions, and upon the fortune of events for results. A shakiness of the hand may be some bar to the success of an operation, but he of a shaky mind is hopeless. In the handling of a sharp instrument in connection with the human body a confusion of the intellect is worse than chorea.

The actual manipulative part of surgery requires no very great skill, and many an artisan shows infinitely more adeptness in his daily work. A wood engraver would probably soon find as little difficulty in baring the carotid artery as a stone carver would find in performing osteotomy.

It is in the mental processes involved in an operation that

not a few fail. There is some lack in the precision, the strained attention, the art of meeting any possibility, and the capacity for forming a ready judgment, which must follow each movement of the surgeon's knife.

Some of the most incredible examples of surgical blundering, as the fashioning of flaps in such a way as to amputate the trunk from the limb, and the opening of the stomach in mistake for the colon in performing a lumbar colotomy, are calamities due to mental rather than to physical defects.

The mere handicraftsmanship of surgery depends, as has been already said, not only upon natural physical endowments, but also upon careful practice and education. Some men are born with steady, dexterous fingers and precise and quick-moving muscles; others overcome, with more or less success, a congenital and obstinate clumsiness.

Every pains should be taken to cultivate what may be termed *a surgical hand*. A shaky hand may be born with its possessor, and may remain unaffected by any attempts to amend it. This important defect may also be developed by irregular modes of living, by the immoderate use of alcohol, and by smoking. The effect of tobacco is obvious enough in most instances, although its influence may be very transient.

The full use of the larger muscles as developed by vigorous athletic exercises adds distinctly to the steadiness of the hand, and of his general muscular development an operator should be most careful. Athletic exercises involving the upper limbs, such as fencing, rowing, and practice in a gymnasium, certainly render the hand for some hours after such exercise unsteady, although after a longer period of rest precision in the action of the smaller muscles is with equal certainty improved. In connection with this point, it is needless to say that violent exertion on the part of the operator is not wise immediately before an operation. A surgeon who is careful of the manner in which his scalpel is held should not carry a heavy bag to the scene of his labours, nor should he take part in such muscular exertions as are needed to move operating tables or beds, or to lift a heavy

patient. The efforts which may be necessary to restrain the violence of a patient under chloroform are apt to render the arms of those so engaged very tremulous.

The action of the palmar muscles can be very admirably developed by such occupations for a leisure hour as etching on copper, sketching, or wood carving.

A knowledge of *anatomy* is essential to the operating surgeon. Such knowledge as is needed, however, is not to be obtained from books alone, or even from books in preponderating degree. It must be such "anatomy" as is to be acquired by long work in the dissecting-room, and it may not be too much to say that he who would deliberately adopt the career of an operating surgeon should have served for some years the dreary apprenticeship involved by the duties of a demonstrator of anatomy.

Not only does such work teach the position and relation of parts, but it, and it alone, can instil into the mind and the fingers a proper *appreciation of tissues*, and the knowledge of what may be termed the *anatomy of the individual*. A surgeon may know well the origin, insertion, and relations of the parietal muscles of the abdomen, but he who has dissected and demonstrated the lumbar region in "subjects" of all kinds, many times over, has also a knowledge of the depth, the thickness, the appearance, and the disposition of the tissues, not as they lie in an abstract body, but as they may be expected to be found in individuals of different types.

Moreover, the work of dissection affords the most excellent training in the handicraftsmanship of the future operator.

Precision of knowledge, precision of judgment, precision of hand, are all needed in a surgical operation. They are the foundation of the coolness and the sang-froid of which a surgeon is presumed to be possessed, and it is to their absence that can usually be ascribed that condition of mind known as "surgical delirium."

He who is about to undertake an operation should know precisely what he intends to do, and should then proceed to

do it. He should have estimated probabilities, and be quite decided as to his mode of dealing with them.

The individual who plunges into an operation with an uncertainty he would condemn in the pursuit of an ordinary business undertaking, and who discards anatomical precision for the old maxim "cut and tie," is likely to reap the reward of his labours.

The surgeon's *precision* should apply to every detail of the operation and its surroundings. He should select and arrange and examine his instruments with the greatest care; should consider himself responsible for the minutest detail in the needed sterilisation; and should have a proper respect for the magnitude of small things.

The *assistants* at an operation have an exceedingly important office to fill, and their capacity for their work must necessarily vary. It is part of an operator's duty to see that each assistant is fully informed of what he has to do, and, if possible, of the manner of his doing it. An unsuccessful operation is often attended by much abuse of the assistants, and by very severe criticisms of their manipulative powers. Such condemnation may be just, or may only serve to illustrate the proverb that "a bad workman complains of his tools." It is during the most perplexing stages of an operation, and when things are going ill, that the indifferent operator finds that knives will not cut, that forceps will not hold, and that the clumsiness of assistants is beyond the limits of human belief.

In the matter of *dress*, the operator should wear a sterilised linen jacket, the sleeves of which are rolled up to the elbows. This jacket must entirely cover his ordinary clothes from the collar downwards. A perfectly clean mackintosh apron (without sleeves) is usually worn under this.

The use of rubber gloves when operating has been widely adopted. Certainly all those who assist should wear them, but we do not think that they should be obligatory on the part of the surgeon. Even the thinnest rubber lessens that delicacy of touch and precision in the use of the fingers that are of such

primary importance in a difficult operation. The matter may well be left to the surgeon's experience and individual opinion. It is interesting to note that at some important German clinics the use of rubber gloves has been abandoned after full trial in favour of cotton ones, which, of course, the surgeon frequently changes whilst operating. It is stated that in the rubber pores pathogenic germs were often found to be alive in spite of prolonged boiling!

Sterilised linen caps should certainly be worn by operator and assistants. Some surgeons go so far as to cover their faces with linen or gauze masks, and many wear large rubber boots. It is told of one surgeon that before driving to an operation his carriage wheels were always washed over with ether and carbolic solution!

CHAPTER III

THE OPERATING THEATRE AND ITS FITTINGS

A MODERN **operating theatre,** fitted with all accessories for sterilising instruments, dressings, and water, forms a very elaborate and costly department of a hospital. In the following description the new theatres at the London Hospital have been taken as the example. They occupy, with rooms for sterilising, for anæsthetising the patients, for the surgeons and dressers, etc., an entire floor. They are lighted by electricity, and are warmed partly by hot-water pipes, partly by warm filtered air, the supply of which can be regulated exactly. The water is all sterilised. To simplify the description, a number of illustrations are given, which have been kindly furnished by Mr. E. W. Morris, from photographs taken by Messrs. W. E. Wright and Sons, of Forest Gate.

In the centre (Plate I.) is the operating table, to the left of which are tables for instrument-dishes and for ligatures, etc., and a tripod with a powerful electric bull's-eye lamp mounted on an adjustable arm. In front of the table is the anæsthetist's seat; above the table is the electric transmitting attachment by which the cautery, motor for drills, and any extra lamps can be instantly put in action. To the right of the table from before backwards are the spectators' gallery (which can be easily moved), slabs fixed to the wall for the steriliser and various apparatus connected with sterilisation, and (in the far corner) the protected entrance tube through which warm filtered air is admitted to the theatre. The roof of the theatre is of opaque glass; the window at the end gives light from the north. An electric fan for drawing out the air is placed in the south wall, and cannot be shown in the figure. Below the north window

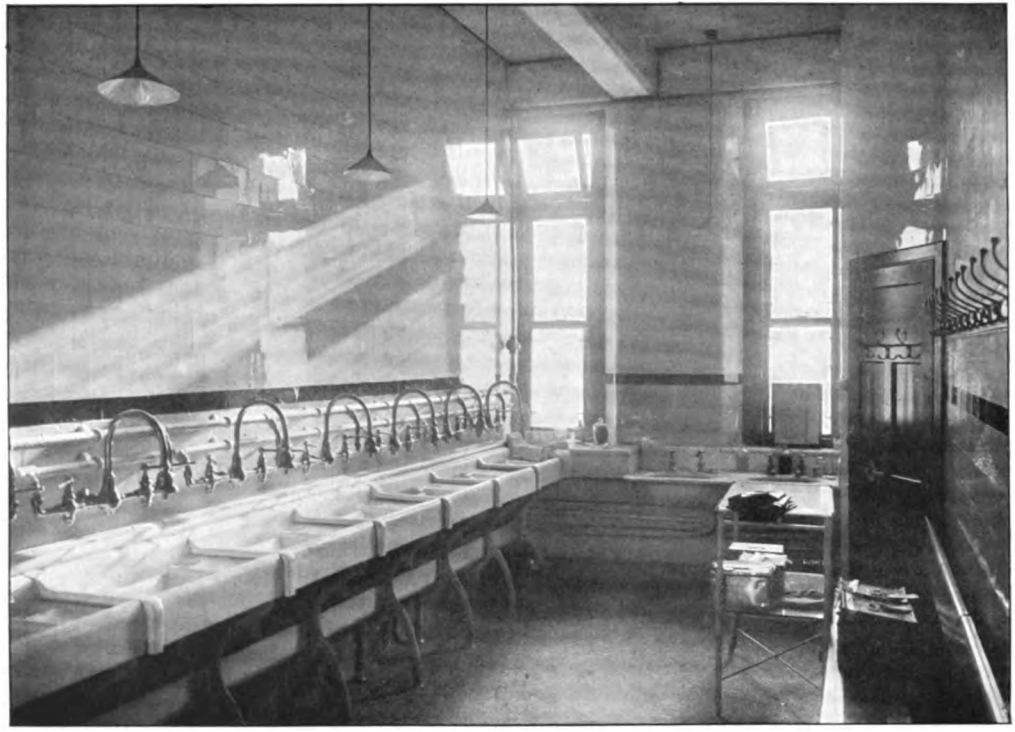

PLATE II.—DRESSERS' ROOM.

(London Hospital.)

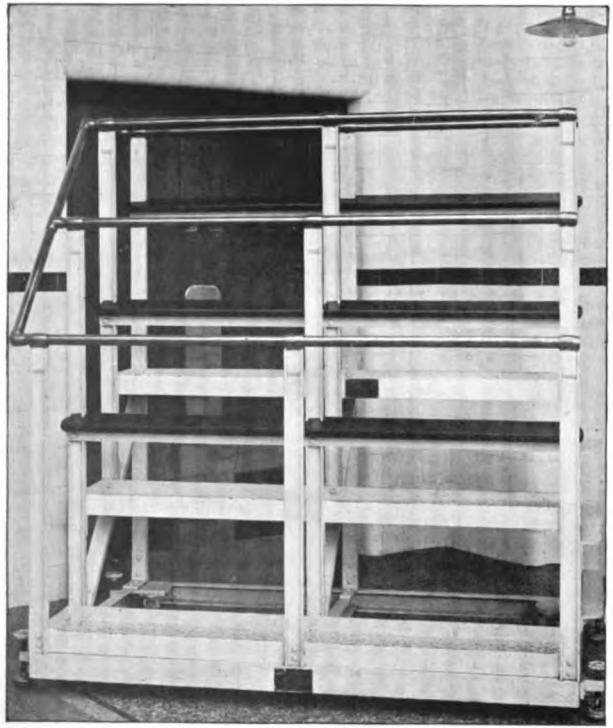

FIG. 1.—MOVABLE SPECTATORS' GALLERY.
(*London Hospital.*)

FIG. 2.—GLASS TABLE FOR SUTURES AND LIGATURES.
(*London Hospital.*)

PLATE III.

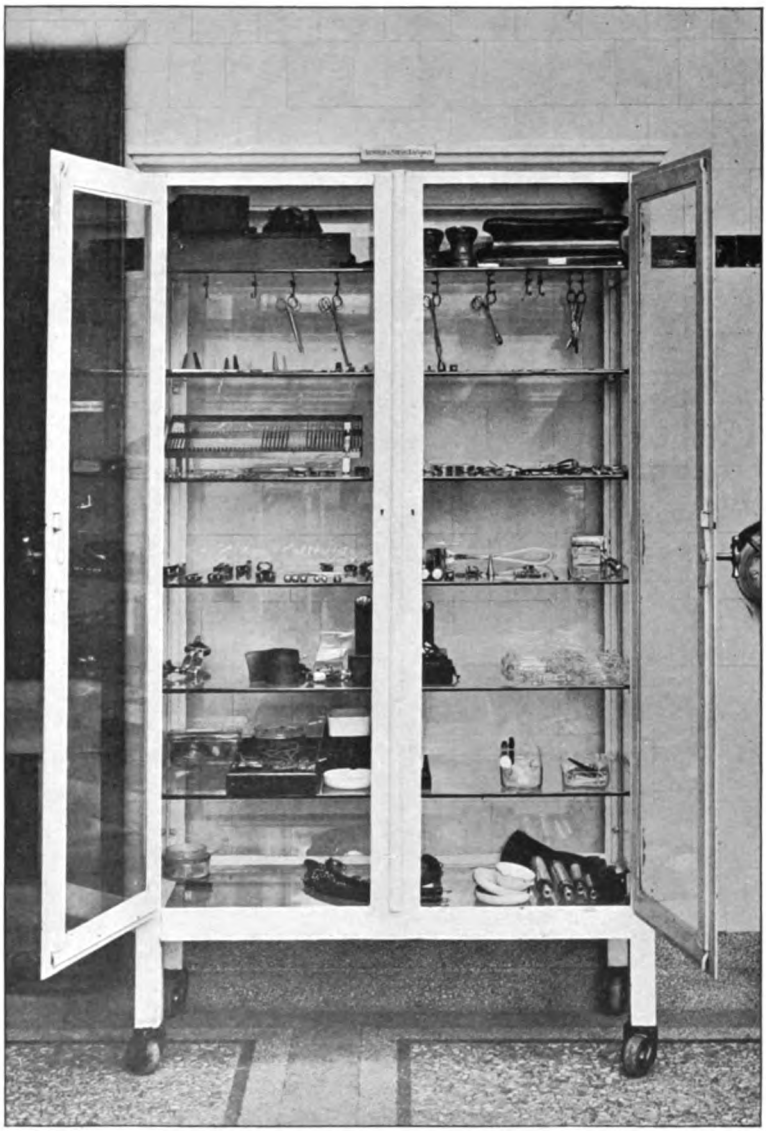

PLATE IV.—INSTRUMENT CABINET.

(London Hospital.)

are basins and taps for the dressers, theatre assistants, and nurses. In front of the basins for the nurses is a metal box for soiled dressings. On the extreme left are seen an instrument cupboard made of metal and glass, and a stand for sterilised towels, dressings, antiseptic lotion jars, etc.

The walls and floor are lined with polished cement or tiles, and all angles are rounded off. The floor slopes gently to an open gulley drain. All fittings are of metal, marble, or glass, and the tables, being on wheels, can be easily moved to allow of the whole theatre being washed out with a hose and hot water.

Plate II. shows the dressers' room, in which the students and house surgeons, who are to assist in the theatre, prepare themselves. After removing his coat and rolling up his shirt-sleeves well above the elbow, each dresser washes his hands and forearms in running water for five minutes at the basins shown on the left. The taps have long handles, which can be turned by elbow pressure. The basins are self-emptying. The chief chemical disinfectants used are lysol, biniodide of mercury in alcohol, and carbolic acid. A sterilised linen coat is taken from one of the boxes seen on the right; the coat-sleeves entirely cover the arms, and are rolled up as far as the elbows. Under the coat a mackintosh apron is usually worn. Before going into the theatre the hands are again cleansed. All doors are swinging ones without handles, so that no chance of contamination through them is incurred. Sterilised pure rubber gloves are worn by the assistants.

Spectators in the theatre are confined to the movable stand or gallery shown in Plate III., Fig. 1. This stand is on large screws, with rubber feet, so that it may be moved to either side or either end of the operating table. It is made of metal throughout, for convenience of disinfection, and will accommodate ten or twelve spectators. In some hospitals, and in one of the theatres at the London Hospital, is a fixed gallery of stone or marble. As this is raised above the level of the table, it must be provided with an impermeable front of stone

or of iron, in order that dust from the spectators' feet may not be carried into the area.

Fig. 2 in Plate III. represents the glass table for sutures and ligatures. Attention is drawn to the trough jars on its top for keeping sterile silk, catgut, and tendon threads in solution. The upper end of each jar has a broad trough in which the cover rests, the trough being partly filled with antiseptic solution. The jar is thus rendered absolutely air-tight on merely replacing the glass cover. These jars were devised by Mr. Morris for the London Hospital.

Plate IV. shows one of the instrument cabinets, with glass shelves and door. The block on the top shelf is placed beneath the patient's pelvis during the application of a bandage round the groin. On the third shelf from the top is the metal knife tray.

Whilst the instruments are conveniently sterilised in the theatre by being boiled by high-pressure steam on the bench or marble slab shown in Plate V., the sterilisation of dressings, wool sponges, ligature jars, and the like is carried out in a special room.

In Plate VI. the main steriliser is shown open; the trolley on which are placed the ligature jars and copper boxes holding dressings of gauze and wool is seen about to be pushed on rails through the opening. The door is then shut to and secured with screw clamps of great strength. Superheated steam under high pressure is now driven into the chamber, and after a sufficient time has elapsed it is exhausted, so that the sterilised articles come out practically dry.

An ingenious arrangement for rendering instrument trays, porringers, basins, etc., sterile is shown in Plate VII., Fig. 1. Each theatre is supplied with a double set of these large copper boilers and wire holders, one set being boiled whilst the other is in use. Steam at high temperature and pressure is employed for heating the theatre sterilisers. By this means all gas burners in the theatre are dispensed with.

In each theatre is a metal box with hinged lid for boiled dressings, etc., as seen in Plate VII., Fig. 2.

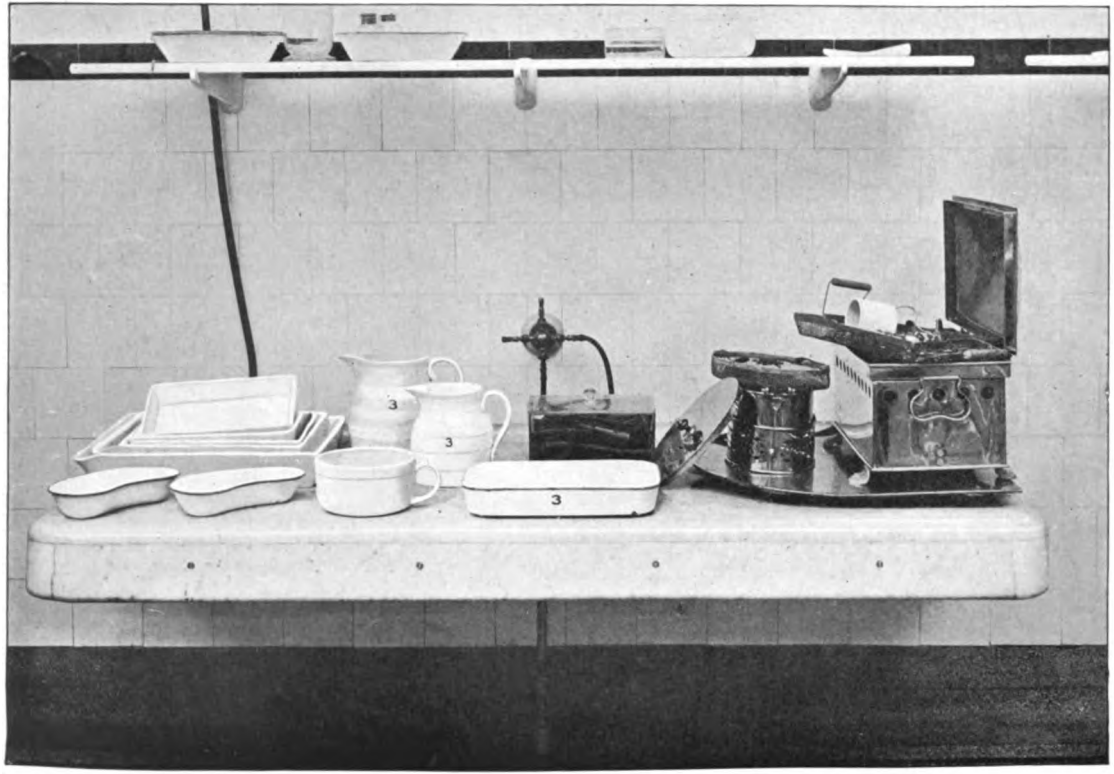

PLATE V.—MARBLE SLAB ON WHICH INSTRUMENTS, ETC. ARE STERILISED BY HIGH PRESSURE STEAM.

(*London Hospital.*)

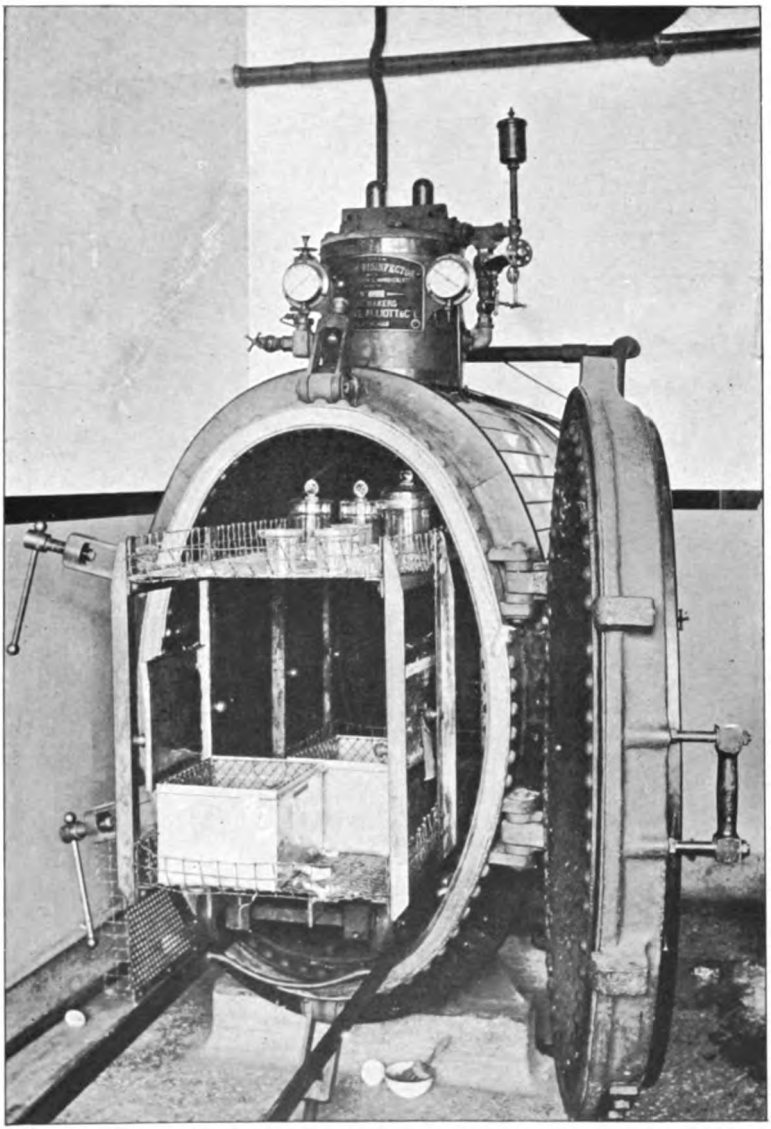

PLATE VI. - MAIN STERILISER.

(*London Hospital.*)

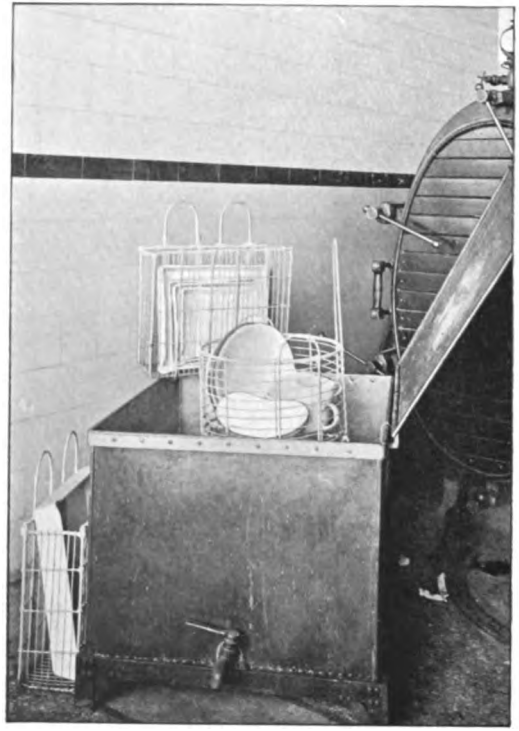

FIG. 1.—STERILISER FOR INSTRUMENT TRAYS BASINS, ETC.
(London Hospital.)

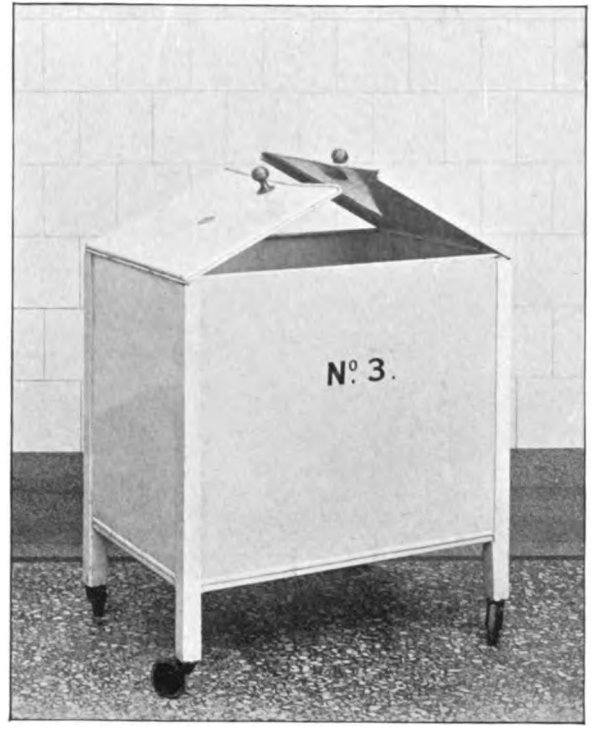

FIG. 2.—METAL BOX FOR SOILED DRESSINGS, ETC.
(London Hospital.)

PLATE VII.

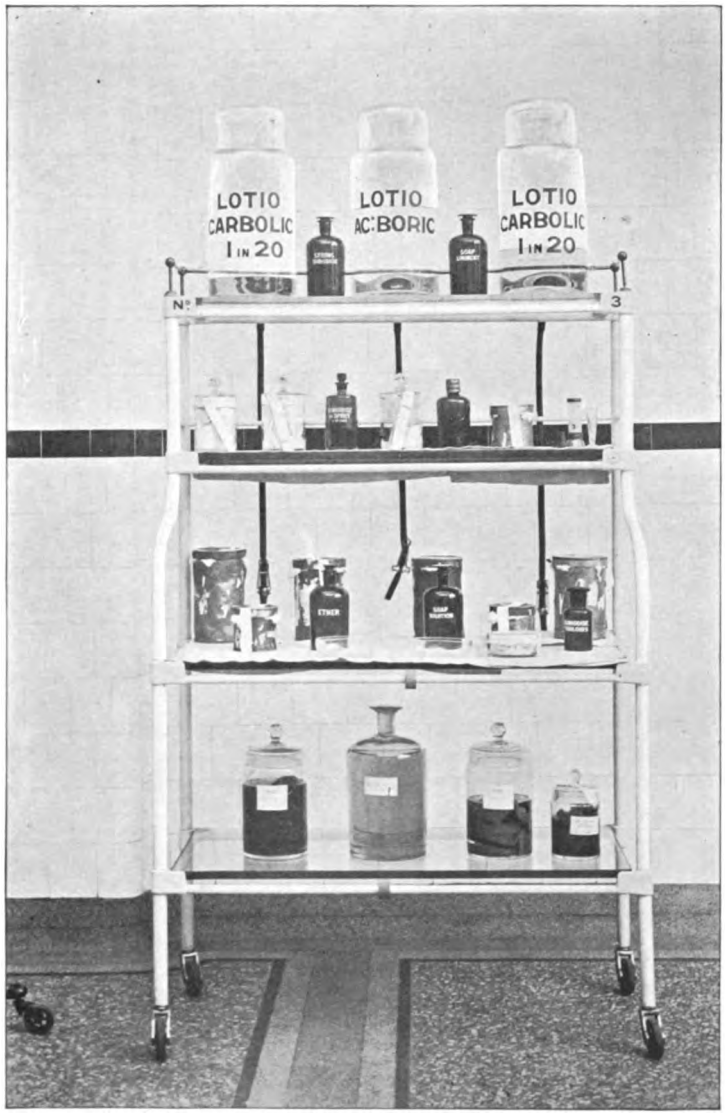

PLATE VIII.—SISTERS' TABLE.
(London Hospital.)

Plate VIII. shows the sisters' table. On the top shelf are lotion jars with flexible rubber tubes attached. On the second shelf are glass and metal cases containing artificial sponges made of wool and Gamgee tissue. These have been sterilised and sealed down with paper slips on which is stamped the date of sterilisation. The third shelf contains similar jars and chemical disinfectants for the skin. The stand can be moved about with ease.

From the foregoing account some idea will have been gained of the elaborate arrangements required in hospital operating work. In the best nursing homes most of the details referred to are carried out on a smaller scale but with equal efficiency.

OPERATIONS IN A PRIVATE HOUSE

It remains now to describe the preparations which should be made for an operation in a private house. Provided that the greatest care is exercised, there is no reason why as complete asepsis should not be secured in the patient's room as in the most elaborately fitted hospital theatre.

It is, in the first place, essential that the house be in a perfectly ***sanitary condition***, and as it appears to be an article of the householder's faith that the hygienic state of his or her premises is exceptionally perfect, it is well that the building should be examined by a skilled person without the residential bias.

Before the operation the patient should sleep in a room other than that in which the operation is to be performed. It is in the operation room that the patient should remain during the after-treatment.

This room should be made as nearly like a hospital ward as possible. All unnecessary hangings and curtains should be removed. It should be bared of all but absolutely essential furniture. It is often recommended that the carpet should be be taken up. This is desirable, but it is hardly necessary, and may lead to disturbance of dust. A large damp sheet or waterproof fastened over the carpet will be as effectual and cause less trouble. The walls should be brushed down and the floor

scrubbed if the boards have been exposed, and the room must be well ventilated on the previous day by open windows and a large fire. The cleaning of the room, and especially the dusting of it, must be completed at least twenty-four hours before the operation. The room had better be left altogether untouched than be vigorously " dusted " just before the operation. Nothing can possibly be worse than dust in circulation at the time of the operation.

The room should be quiet, light, and well ventilated, and is pleasanter if its windows look towards the south. It should not be near a water-closet. An open fireplace is most desirable, and the less gas burnt in the room the better. It should be ascertained that the windows open readily.

The *temperature* of the room during and after the operation should be kept at from 60° to 65°, and should not be allowed to fluctuate. During abdominal operations a somewhat higher temperature is desirable.

The Patient's Bed.—The patient's bed should be a narrow, simple iron bedstead, with a woven spring body, upon which is placed a horsehair mattress. There should be no rail on either side, and but a low one at the head or foot. The bed should be so located in the room that the patient will be accessible from all sides, and the wound be dressed with ease.

It is usually most convenient that the bed should stand in the centre of the room, and be so arranged that the head is towards the light—that is to say, as the patient lies in bed the light will be behind him.

A bed in a corner is always inconvenient, the patient being accessible from one side only.

To allow a heavy patient, after a serious operation, to return to a large, wide bedstead, covered by a voluminous feather mattress, into the centre of which he helplessly sinks, is to place him in a position of some peril.

After many operations a bed-cradle will be required. In some cases a " bed pulley " may be conveniently affixed to the joist of the ceiling over the head of the patient's head.

The other *accessories* are a large table for sterilisers and basins, and one or more small and light tables for the instruments. The instrument table should be on wheels, so as to be readily moved when required. Receptacles are needed for used swabs or "sponges," and for such evacuations as ascitic fluid or the contents of an ovarian cyst.

A liberal supply of hot and cold boiled water should be at hand, and a suitable provision of pillows, towels, and mackintosh sheets, together with the usual nursing accessories. All the water used for various purposes just before and during the operation should have been well boiled, and all dishes for instruments, sponges, solutions, and ligatures should be thoroughly cleansed in suitable antiseptic solutions and then washed with boiling water. A portable steriliser is essential for instruments, towels, and dressings. It may be heated either by a Bunsen gas-lamp or a suitable spirit-lamp, and should be bestowed in a place of safety and away from a draught.

The Operating Table.—The table employed should be simple, strong, and steady. It is essential that it should be narrow, and of a height convenient to the individual operating. A table with the following measurements will be found convenient: Length, 5 to 6 feet; width, 2 feet; height, 33 inches. It should be covered with either a thin, firm horsehair mattress, or a large and neatly-folded blanket. The latter is the more convenient in operations performed in private houses.

The plan of having two small tables placed in the form of the letter T is decidedly inconvenient. It should be remembered that the table may need to be moved during the operation. For example, in the removal of the tongue, with preliminary ligation of the lingual arteries in the neck, it is not often that the table can be so placed that the light falls equally well upon both sides of the neck. As a good light is very essential for this procedure, the table may have to be placed in one position while the left artery is being secured, and in another when the right is dealt with.

A slender, unsteady table may prove a source of actual

danger. I have seen a table give way entirely while the struggles of the patient were being restrained during the early stages of anæsthetisation.

The crazy contrivances and makeshifts which the patient's friends sometimes consider to be ingenious substitutes for a proper table are to be distinctly avoided. I have a recollection of one altar-like construction, made of four boxes and a small chest of drawers, upon which was recumbent a heavy man, prepared for an excision of a part of the lower jaw.

The operating table illustrated in Plate IX. is in use in all the theatres at the London Hospital, and to Mr. E. W. Morris (in charge of the operating theatres department there) is due the credit of various improvements which it embodies. In each of the figures the patient's head corresponds with the left hand of the table.

The head- and foot-rests are adjustable, and the latter can be instantly removed, so as to be out of the way in operations upon the rectum; the top of the table at the lower extremity can be raised 6 inches, hingeing from the centre of the table; thus the pelvis can be raised for operations upon the bladder. The Trendelenburg movement is obtained by means of a wheel and screw, and can be accurately adjusted.

Fig. 1 in Plate IX. shows the table fixed, the wheels being put out of action by the levers being vertical. It now rests on four metal legs, which project between each pair of wheels. The two foot-rests have been inserted. The table is perfectly steady, and is now as used in most operations, the patient being supine and no special part raised.

Fig. 2 shows the two foot-rests removed and on the floor. The lower portion of the table, on which the thighs of the patient rest, is raised by screw action. The table is "floating"—*i.e.* the levers are down which place it on wheels. These latter work on pivots, so that the table can be turned at once in any position. The wheels are of rubber-covered metal.

Fig. 3 illustrates how the Trendelenburg position is obtained, and also how one leg of the patient may be raised, the other

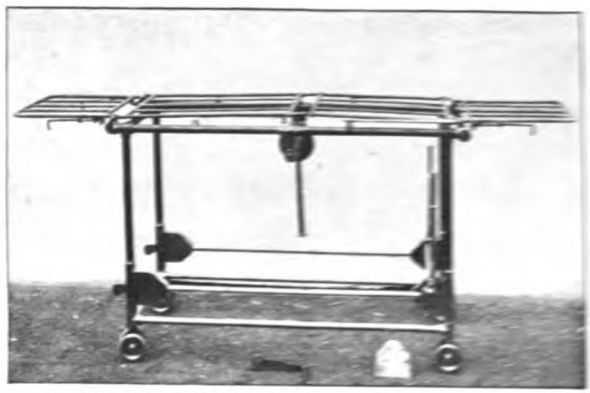

FIG. 1 – OPERATING TABLE AS USED IN ORDINARY POSITIONS

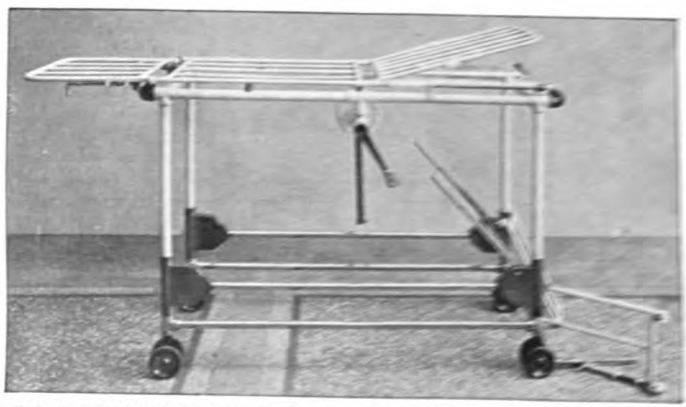

FIG. 2.—THE SAME TABLE "FLOATING" WITH THE FOOT-RESTS REMOVED

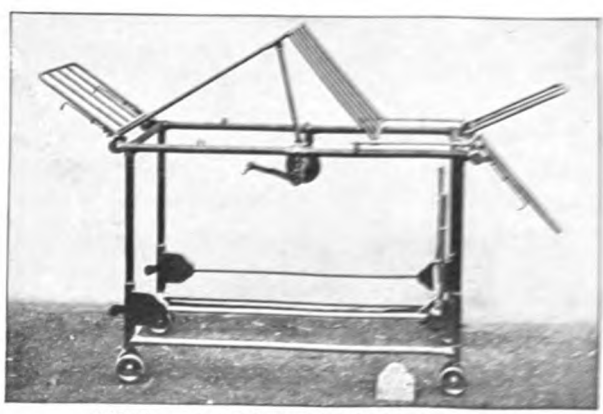

FIG. 3.—THE TRENDELENBURG POSITION.

PLATE IX.

depressed, by altering the slope of the foot-pieces. All these movements are effected by screw action, and are therefore capable of exact graduation.

One valuable feature of the London Hospital operating table is the mechanism for raising the whole level of the top some 6 inches if required.

It is comparatively an inexpensive table, costing only about £25 complete.

The table just described is, however, not a portable one, and

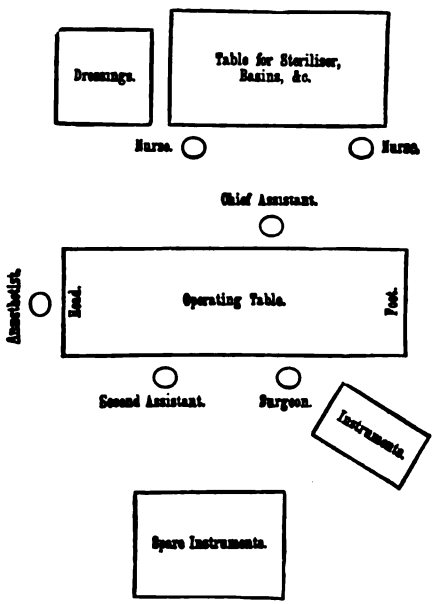

FIG. 1.—DIAGRAM SHOWING ARRANGEMENT OF SURGEON'S TABLES.

a much lighter form which folds up is required for taking to a patient's house. Several excellent types of this have been devised. With regard to the modern tables used in operating theatres, it may be noted that enamelled metal is nearly always preferred to wood in their construction, and that the ingenuity of their makers has often led to undue complexity. For example, a copper bath is sometimes included, with the idea of

maintaining the patient's temperature. This is an expensive and useless encumbrance. Whilst it is essential that the table should allow of the Trendelenburg position, simplicity of construction in other respects is an advantage.

Arrangement of the Tables, etc.—The operating table should be placed in the best attainable light, and, in the case of most operations, with the patient's feet towards the windows. If there be two windows near together in the same wall of the room, the table may be so placed as to be at right angles to the wall, and to have its foot opposite the space between the two sources of light. There should be sufficient room on all sides of the table to allow an individual to pass freely.

The general disposition of the tables, and of the surgeon and his assistants, is illustrated in the diagram (Fig. 1), which may be considered to relate to such an operation as the radical cure of hernia or the removal of a tumour from the thigh.

The anæsthetist stands at the head of the table, and the operator on the patient's right. Close to the surgeon's right hand is a light table on wheels for the necessary instruments.

A larger table for accessory and spare instruments may be placed at a distance behind the operator.

The chief assistant stands on the left side of the table, opposite the surgeon. It is by this assistant that the sponging is done and the hæmorrhage attended to.

Behind this assistant, and entirely to the left, is a large table for the steriliser, basins, receivers, jars of lotion, etc., and at this table the two nurses are placed.

A smaller table may stand close to the larger one, to take the dressings necessary for the case.

A second assistant, if needed, may place himself to the operator's left and on the right-hand side of the operating table.

CHAPTER IV

THE INSTRUMENTS AND ACCESSORIES

THE operator should attend personally to the selection and care of all instruments, and to the minutest matters which concern them.

They should be in perfect condition, and above all things aseptic at the moment of use.

For this reason all instruments, if possible, should be made of metal throughout, so that they can be sterilised with ease by boiling in a weak solution of carbonate of soda (about one per cent., or one and a half drachms to the pint). Sharp cutting instruments, knives and scissors, are, however, certain to be blunted by this treatment ; and it is important to remember that they are ruined by solutions of bichloride of mercury. If the cutting instruments be not boiled, they should be treated with an alcoholic solution of carbolic acid (1 in 20) immediately before use, and thoroughly cleaned after each operation with a brush, etc. A convenient steriliser is shown on page 59, Fig. 23.

In the *selection of instruments*, each manipulator must exercise his own taste, and found his choice upon his habit of hand. It is improbable that twenty men would select the same pen or penholder out of a collection of twenty samples, but they might all write equally well.

Ingenious instruments which fold up into a small compass, or which combine many functions, are usually to be avoided.

There is no doubt that the fewer the implements to which a surgeon accustoms himself, and the simpler they are, the better. As has been already said, the surgeon's work is a handicraft. He should depend more upon his fingers than upon his tools. He who is really expert with one instrument has an advantage over him who is indifferently familiar with many.

The best work is done with the simplest implements. A surgeon who is dependent upon a special instrument for this, and a special instrument for that, is a poor handicraftsman. He is servilely subject to his special forceps and his particular knives and needles for a particular operation. For instance, the surgeon who cannot excise the vermiform appendix without inventing a clamp for the purpose has mistaken his vocation.

Some of the least progressive periods in the development of the surgeon's art have been marked by the prolific production of instruments. With few exceptions, complex apparatus and appliances which are credited with being ingenious, or labour-saving, or automatic, are bad.

A great multitude of the instruments which figure in the makers' catalogues are evidences of incompetence and of a lack of dexterity which prevented the inventor from making full use of his hands.

A great deal can be done in operative surgery with a scalpel and a pair of dissecting forceps, and, indeed, there is but comparatively little that cannot in some way be accomplished with those instruments.

A brief notice is here given of the simplest, most general, and most essential instruments. The special instruments are considered in the chapters dealing with the procedures with which they are concerned.

The scalpel should be light, and should have a handle of good length, which should be thin and made of metal.

A length of four inches for the handle, and a width of from three-eighths to half an inch, are convenient. A shorter handle does not rest properly in the hand; it is like a too short pen-holder or paint-brush. A longer handle is unnecessary.

The breadth and width of the handle may possibly vary a little with the size of the blade, but the length should not vary. A scalpel with a small and very fine blade does not need a handle proportionately reduced. Indeed, the most excellent small scalpels are those which had originally blades of good size, but which have been reduced to slender and short proportions by

repeated grinding. Although small in the blade, they still retain the original handle.

The blade should be what instrument-makers call "middle-pointed"—*i.e.* the point should lie on the long axis of the steel (Fig. 2, A).

A "back-pointed" blade is not well suited for the scalpel. It answers for larger knives, which are broad in the blade and are required to make large and free incisions; for example, the handiest form of post-mortem knife and of cartilage knife is back-pointed.

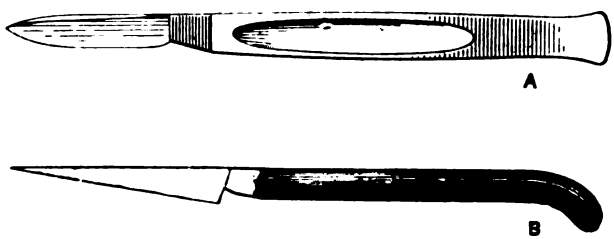

FIG. 2.—(A) GOOD SCALPEL, MADE OF STEEL THROUGHOUT. (B) BAD SCALPEL. (From a modern catalogue of instruments.)

Very fine scalpels are a grievous delusion. If a beginner is about to undertake an operation involving a "fine" dissection, he will probably seek a knife with a very fine point. Such a knife is depicted in Fig. 2, B, and is copied from a catalogue of instruments. It is a useless tool; it is, indeed, a needle, not a knife. A surgeon who once attempts to perform a fine plastic operation with such an instrument will probably discard the knife for ever.

A small scalpel, with a good blade and a "middle point," and with such an outline as is depicted in Fig. 2, A, is the best instrument for the finest work the operator can be called upon to perform. The very fine back-pointed knife will scratch, but it will not cut.

The back of a scalpel should be blunt up to the very point. Double-edged knives are purposeless in any operation, and the surgeon's fingers are apt to be cut by them.

The ordinary forms of *bistoury* have handles somewhat more substantial than those of scalpels, and they are convenient if a little roughened, but the length of the handle need not be much in excess of that of the scalpel.

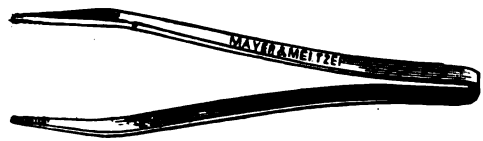

FIG. 3.—DISSECTING FORCEPS OF A SINGLE PIECE OF STEEL.

FIG. 4.—DISSECTING FORCEPS IN TWO PARTS, WHICH CAN BE READILY SEPARATED FOR CLEANSING PURPOSES.

A straight probe-pointed bistoury, with a blade two and a half inches in length, is the most useful instrument of the class.

Dissecting Forceps should have a good spring, should be

FIG. 5.—TOOTHED FORCEPS.

short, and should not be too narrow at the points. Four and a quarter inches is a very convenient length. Dissecting forceps are not uncommonly too lightly and too frailly made to be

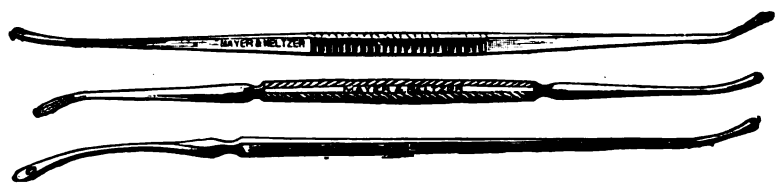

FIG. 6.—VARIETIES OF BLUNT DISSECTOR.

serviceable. The strength of the spring must depend upon individual taste. For all ordinary purposes a good broad point is desirable; it enables the surgeon to obtain a firm grasp of the

tissues, and at the same time does not prevent a very small fragment of tissue from being picked up (Fig. 3).

In another convenient form the two blades can be disarticulated so that they can be easily cleaned (Fig. 4).

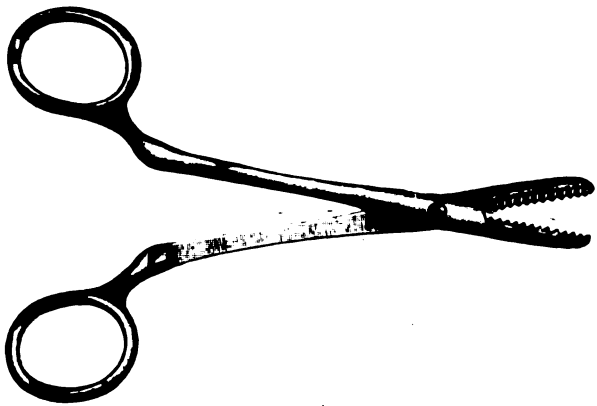

FIG. 7.—SPENCER WELLS' ARTERY FORCEPS.

Important aids to operating are toothed forceps (Fig. 5), and the so-called dissectors, different forms of which are shown in Fig. 6. Toothed forceps do not slip from their hold as dissecting forceps are liable to, and will be found essential in hernia operations and a number of others.

The dissectors are very useful in exposing arteries and nerves, in enucleating glands, in separating adhesions to the vermiform appendix, and in many other operations.

Artery Forceps.—The pressure forceps of Sir Spencer Wells are simply invaluable, and have proved to be one of the most important recent additions to the surgeon's armamentarium.

The best instruments are those of the original pattern (Fig. 7), and there is little or nothing to be said in favour of the various "modifications" and "improved forms."

FIG. 8. — WELLS' FORCEPS WITH TAPERING POINT.

It should be noted that there is a tendency to

make the Wells forceps too clumsy and thick at their grasping ends. A light pair, tapering to the point, will be found the best (Fig. 8, which gives the exact size). It is then easy to tie any artery which has been seized, and the necessity for any special artery-ligature forceps is done away with.

In the same way, for twisting an artery no special instrument is required. Wells' pressure forceps form the simplest torsion forceps, and may take the place of the many complicated instruments known by the latter name.

FIG. 9.—BLUNT HOOK (reduced ½).

Retractors.—The simplest form of retractor is provided by the Wells forceps held by the assistant. They are, moreover, free from the possible risk of infection through the fingers used as retractors.

In certain operations, and especially in the case of deep wounds, some special means of retracting the soft parts or the skin is required.

In a later section is described (page 67) the method of retracting the skin in many small operations, such as the removal

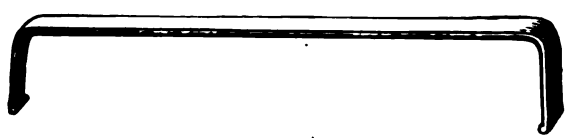

FIG. 10.—FARABEUF'S RETRACTOR.

of a superficial tumour or the radical cure of varicocele by means of ligatures. This method leaves the area of the operation wound quite free.

To draw special tissues aside, such as a tendon, a nerve, or a vein, blunt hooks answer admirably. They take up little room, and encroach but little upon the area of the operation. They should be long enough and large enough for the purpose, and are made of plated steel (Fig. 9).

Amongst other wound retractors, a handy and efficient form is that of Farabeuf (Fig. 10), which is made in many sizes. The

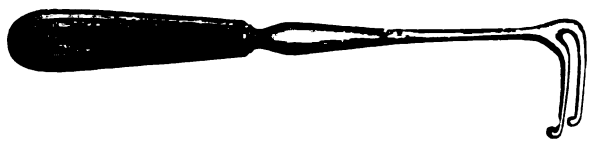

FIG. 11.—FARABEUF'S MODIFICATION OF LANGENBECK'S RETRACTOR.

little turn at the end of the metal gives it an excellent hold of the tissues. A very convenient instrument also is Farabeuf's modification of Langenbeck's retractor, shown in Fig. 11.

These are excellent substitutes for the broad copper spatulæ and retractors of less recent times, which bent when exposed to much strain, and slipped unless that strain was kept up. For deep wounds, such as that made in nephrectomy, the large rectangular "kidney retractor" may be necessary.

Needles.—The best suture needle is a perfectly straight one, of a length adapted to the case in hand, and "triangular-pointed" (Fig. 13, A). Straight "lancet-pointed" needles are much used, but they are not so serviceable as those first named.

For special operations special needles are required, such as in suturing intestine and in operations for cleft palate and certain fistulæ, but for all ordinary suture purposes the best instrument is the straight needle. For use with fine Japanese silk the calyx-eyed needles are convenient, the thread being more easily inserted than in the others.

Many surgical needles need only to be mentioned to be strongly condemned. These are the large-curved needles and the half-

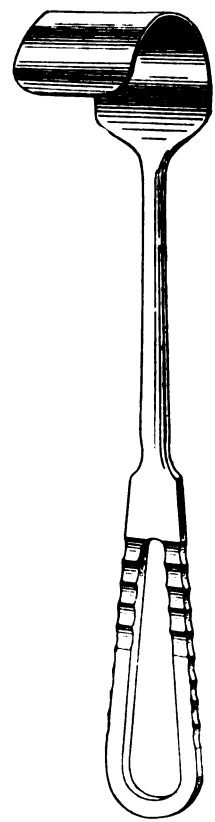

FIG. 12.—A GOOD RETRACTOR FOR DEEP WOUNDS.

curved needles which are found in most pocket cases, and which are currently supposed to be used for sewing up wounds of the scalp (Fig. 13, B). If any operator acquires perfect control over these unreasonably-shaped needles, they may possibly be of service. I have observed a half-curved needle to

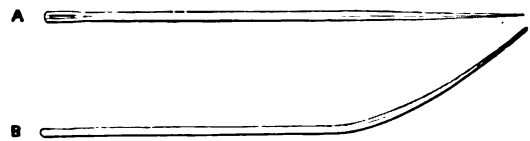

FIG. 13.—(A) STRAIGHT TRIANGULAR-POINTED SUTURE NEEDLE; (B) HALF-CURVED SUTURE NEEDLE (A USELESS INSTRUMENT).

be introduced at one spot and its point to emerge at another at some distance from the intended aperture. The surprised operator has withdrawn it, and on making another attempt the needle point has again emerged at a remote and unexpected locality.

In Fig. 14 Hagedorn's flattened needles, straight and

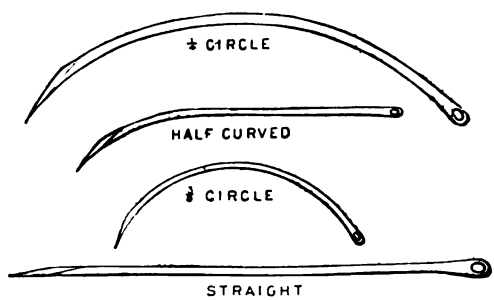

FIG. 14.—TYPES OF HAGEDORN'S NEEDLES, WITH FLATTENED SIDES, OVAL EYES, AND BLADE-LIKE ENDS.

curved, are shown. These require a special needle-holder, which is very apt to wear and to lose its proper grip of the needle. We do not therefore advise the original Hagedorn type, having entirely discarded his holder.

Of curved needles, one of the best is "Hagedorn's reversed," in which the end towards the point is compressed from side to

side, whilst the half towards the eye is curved on the flat. The latter portion is held in the needle-holder (Fig. 15).

In sewing up a thick abdominal wall the surgeon may be troubled to find the best needle. Straight ones are out of the question; at any rate, fully curved (half-circle) ones are far more convenient, and safe. Fig. 15 shows the exact size of the needle we have found the best for this purpose; it should be made of the finest English steel.

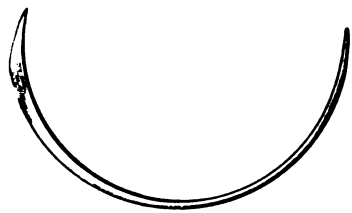

FIG. 15.—HAGEDORN'S REVERSED NEEDLE.

Provided that the assistant wears rubber gloves there is no risk involved in his threading the needles during the operation. It is, however, convenient, especially for intestinal or stomach operations, to have a supply of needles threaded with fine silk

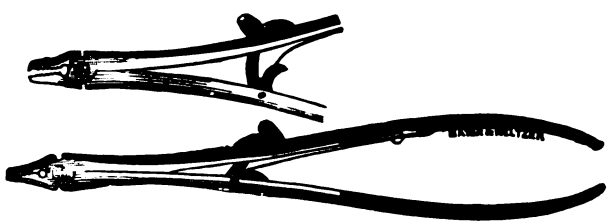

FIG. 16.—COLLIN'S NEEDLE-HOLDER WITH OPENING CATCH, FOR STRAIGHT NEEDLES. (In the upper figure the needle-holder is open.)

and kept on small glass spools in alcohol, after they have been first sterilised by boiling. For the occurrence of stitch-abscess the organisms in the deep epidermic layer of the patient were formerly blamed. This may have been partly correct, but it is certain that contamination in the act of threading the suture was sometimes to blame. With modern precautions stitch abscesses have disappeared.

For holding straight needles Collin's latest needle-holder can be strongly recommended (Fig. 16). It is especially adapted

for the flat Hagedorn's needles (Fig. 14), and it holds the needle with just sufficient firmness of grip.

A very excellent needle-holder for small curved needles of

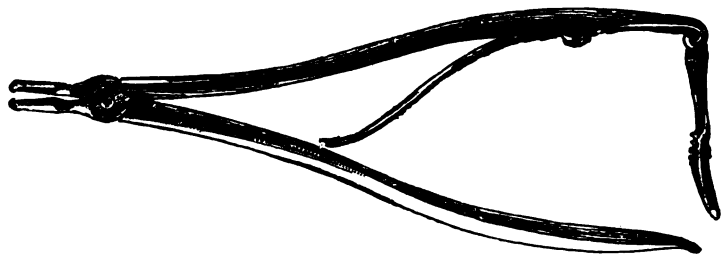

FIG. 17.—NEEDLE-HOLDER ADAPTED FOR ALL ORDINARY CURVED NEEDLES. RAMPLEY'S PATTERN, ¾ actual size.

the ordinary pattern is the simple instrument depicted in Fig. 17. Another excellent needle-holder is shown in Fig. 18.

Suture Material.—The best suture material, so far as our experience goes, for operation wounds of almost any kind, is *silkworm gut*. It is in the first place strong; it is as smooth as glass, and as solid. As it is not composed of fibres, the fluids of

FIG. 18.—SIMPLE NEEDLE-HOLDER.

the wound cannot soak into its substance, and therefore if it be retained for longer than the usual time it does not act as a seton. We have frequently, under special circumstances, allowed silkworm gut sutures to remain in position for fourteen days, and in cases of cleft palate for three weeks, and no harm has resulted.

In the case of wounds which require support for some time after the operation, as in the wound left after the removal of a mammary tumour, together with much skin, it is better, if possible, that the original sutures should be retained than that they should be removed and their place taken by strapping.

Silk sutures must be removed early. It is not to be inferred that the use of silkworm gut should encourage the practice of retaining sutures unduly. A suture should be removed as soon as it can be, but with silkworm gut it is possible to retain the support of the suture in those occasional cases in which such retention is of advantage.

In the next place, silkworm gut, although stiff, moulds itself to the position it is made to assume in the wound. Its perfect smoothness renders it easy to introduce, and this quality, combined with its pliability, renders it easy to remove.

FIG. 19.—FIRST STAGE OF THE SURGEON'S KNOT.

Silkworm gut sutures should be allowed to soak in sterile warm water for some ten minutes before use. Such immersion renders them less slippery and less stiff.

The suture is secured by making use of the first stage of what Fergusson calls the surgeon's knot, "which is made by passing one end of the thread twice over the other (Fig. 19), before turning each back again to form the second noose" (Fig. 20).

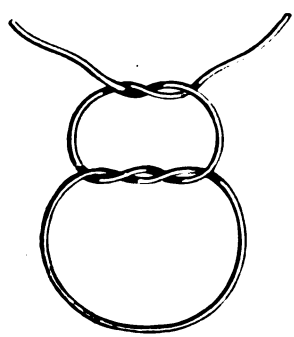

FIG. 20.—SURGEON'S KNOT.

With silkworm gut this second noose is often unnecessary. The thread should be twisted as shown in Fig. 19, and then pulled tight. If properly applied, it will not give. In this matter of securing the suture, silkworm gut presents a great advantage over other materials. There is no knot to press upon the tissues; the interwoven suture threads lie absolutely flat, and the edges of the wound are approximated with the greatest precision. For plastic operations and for such a procedure as the closure of a ruptured perineum, this suture material is invaluable. The threads should be left long, and

it will be found to be possible to loosen or tighten the suture after it has been "tied" as it lies *in situ*.

In cases where the fineness of the resulting scar is a matter of importance, as in operations upon the face or neck, very thin silkworm gut (the so-called "ophthalmic gut") gives admirable results, but in certain positions, such as the eyelids, Japanese silk should be used. Many surgeons use a continuous suture of fine catgut.

It is convenient to stain the silkworm gut sutures with methyl blue or red, as there is then less chance of overlooking them at the time of removal.

FIG. 21.—REEF-KNOT.

In applying this where security is essential (*e.g.* in tying omentum), the threads should be crossed and tied again, making a treble knot.

In the instances in which silkworm gut, by reason of its stiffness, cannot be employed, a silk suture thread may be used.

The best form of silk to employ is that known as "Turner's patent plaited suture silk." It is very readily applied, presents a smooth surface, and shows no disposition to become unravelled, to kink, or to curl up when soaked in water.

The silk thread known as Chinese twist lacks these advantages, and is quite unsuitable for suture material. The Japanese silk, on the other hand, is excellent, being both fine and strong. It stands boiling again and again without deterioration.

All silk used at the operation should be boiled immediately before use.

For wounds made in the scrotum fine catgut sutures are to be recommended. In very long incisions it is a good practice to let the main sutures which take the strain be of silkworm gut, and the intermediate sutures (which merely bring the skin together without strain) of catgut.

Ligature Material.—Catgut is still largely employed for this purpose, especially since improved methods for its manufacture and for rendering it sterile have come into use.

Catgut, however, is unsuitable for tying pedicles—*e.g.* of

ovarian tumours—and is more apt to slip than silk. For all pedicles silk or kangaroo tendon should be employed. The stouter the silk the more likely is it to cause trouble, and comparatively thin silk or tendon will stand strain well. The sterilisation of catgut is attended with some little difficulty. Preservation of the material in oily or aqueous solutions of carbolic acid for however long a time will not destroy the spores, and thick catgut is not penetrated by the antiseptic. Disinfection by heat is, in the case of catgut, a difficult process; but the following method is quite safe. The gut is thoroughly cleansed with ether, folded in convenient lengths on a wooden slip or wound on a spool, and then immersed in a solution of carbolic acid (1 in 20) in ethylic alcohol. Thus preserved in a large glass tube with rubber stopper, it does not deteriorate if kept for months or years. When wanted at the operation the catgut is removed from the tube with sterile forceps and placed in water which has just been boiled and has been allowed to cool. The operator will find it convenient to have several tubes in a case, each tube filled with the alcoholic solution of carbolic acid, one containing catgut, another silk, the third silkworm gut, and the fourth kangaroo tendon (Fig. 22). Another solution which is equally efficacious is an ethereal solution (1 in 500) of corrosive sublimate. Catgut which has been soaking some weeks in this material is quite sterile, and does not deteriorate, no matter how long it remains in the solution.

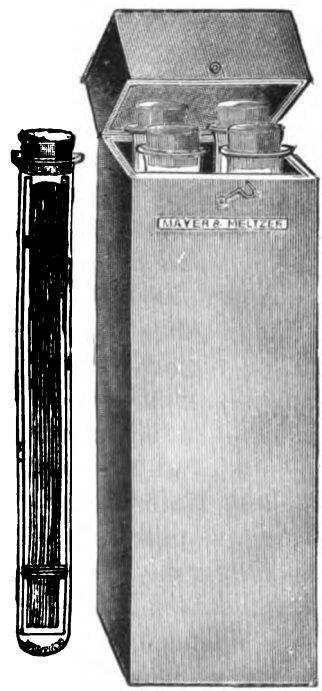

FIG. 22.—TUBES WITH RUBBER PLUGS FOR HOLDING LIGATURES.
(They are filled with 1 in 20 alcoholic solution of carbolic acid.)

Silk has come more and more into use for sutures and ligatures of late years, it has the advantage over catgut of being stronger and much less liable to slip; moreover, it can be readily sterilised by boiling. Many surgeons endorse Kocher's motto, "Away with catgut, and use silk sutures for all aseptic operations." But it should be noted that Kocher insists upon the silk being fine, and on its being prepared and impregnated with antiseptics. His method of preparation is as follows:—

1. Treat with ether for twelve hours, then with alcohol for another twelve.
2. Boil in corrosive sublimate solution (1 in 1,000) for ten minutes, then wind on spools with aseptic precautions.
3. Boil the spools just before the operation in the same sublimate solution.

A simpler method is the following:—

1. After treating the silk with ether, boil for ten minutes, wind on spools and preserve them in 1 in 20 alcoholic solution of carbolic acid, or 1 in 1,000 alcoholic solution of sublimate.
2. Just before use boil for ten minutes in water.

Best Material for Buried Sutures.—For certain purposes where great strength in the sutures is required—*e.g.* in operating on fractured patella, there is nothing better than silver wire, which can of course be sterilised by boiling. Many surgeons have extended its use to such operations as the radical cure of hernia, abdominal section, etc. There does not seem to be sufficient reason for employing such a rigid and possibly irritating material. Fine silk, if thoroughly aseptic, may as a rule be safely buried in the tissues. It answers admirably in wounds of the abdominal wall. But silk, especially if thick, frequently proves a foreign body, and gives rise to troublesome sinuses, from which it is slowly cast out or removed by the surgeon. The same, but to a less degree, applies to silkworm gut.

Kangaroo tendon is beyond doubt the best material for buried sutures; it is easily preserved, and may be had of any required thickness and strength. In an aseptic wound it

becomes incorporated with the surrounding fibrous tissue, and practically never acts as a foreign body. The tendons (obtained from the small kangaroo, or wallaby) should be immediately placed in alcohol, and are thus sterile to start with. As purchased in England, it is usually in the dry form, and can then be rendered perfectly safe by prolonged immersion in the strong alcoholic solution of carbolic acid.

It need hardly be noted that both tendon and catgut are completely spoilt by very hot water.

Sterilisation of Ligatures.—The following methods of sterilising ligatures are those employed at the present time in the London Hospital. They have been supplied by Mr. George Gunthorpe, the head of the Theatre Department :—

Catgut.—(*a*) The catgut, wound on to reels or twisted up into bundles of ligatures, is soaked in ether for twenty-four hours; transferred to a 1 per cent. solution of hyd. biniod. in spir. vini meth., in which it remains for twenty-four hours, and for a further forty-eight hours in a fresh supply of a similar solution; transferred to a 2½ per cent. solution of carbolic acid in spir. vini meth., in which it is kept ready for use.

(*b*) The catgut, after soaking in ether for twenty-four hours, is put into a 5 per cent. solution of carbolic acid in absolute alcohol, in which it remains at least ten days before being used.

(*c*) The catgut, after passing through method (*a*), is

1. Soaked in a 5 per cent. solution of fluid extract of Quebracho in water for twenty-four hours;
2. Washed in running water for six hours;
3. Soaked for forty-eight hours in a 4 per cent. solution of formalin;
4. Washed again under running water for twenty-four hours;
5. Boiled in water for ten minutes, and kept for use in a 2½ per cent. solution of carbolic acid in spir. vini meth.

Sterilised by this (the so-called Japanese) method, the gut remains unabsorbed in the tissues from fifteen to twenty-five days.

(*d*) The catgut is suspended in a cage in the centre of vessel heated by electric current, or superheated steam, and the temperature inside the vessel raised *slowly* to 90° Cent., at which point it is maintained for one hour. Cumol, sufficient completely to cover the catgut, is now poured into the vessel, the lid screwed firmly down, and the temperature slowly raised to 155° Cent., where it is held for forty minutes. The cumol is poured off, and the catgut allowed to dry at a temperature of 90° Cent. for one hour, after which it is transferred to the 2½ per cent. carbolic in spir. vini meth.

Note.—This is the most reliable method of sterilising catgut; it requires, however, a special vessel, and also very careful watching throughout the process, lest the temperature be raised too quickly, or exceed the figures given.

Kangaroo Tendons.—See methods (*a*) and (*b*) for catgut.

Silk.—Unwrap the whole of the silk which is whipped round hank, and wrap the latter loosely in gauze. Boil in water for twenty minutes; drop into rectified spirit for fifteen minutes, and wind on to reels. Boil again in water for ten minutes, and keep ready for use in absolute alcohol, which must be changed three times during the first forty-eight hours.

Silkworm Gut is twisted up into coils of ten strands each, and placed under running hot water for a few minutes to remove the excess of colouring matter; it is then boiled in water for ten minutes, and kept for use in a 5 per cent. solution acid carbolic in water.

The amount of labour involved in carrying out asepsis in a modern hospital can only be described by the term prodigious. The following figures from the London Hospital will give some idea of it:—

Every year, for use in operations and subsequent dressings,

30,000 tins of gauze, wool, etc., are sterilised for wound-dressing. The linen coats worn by the surgeons and dressers, etc., account for 27,000 sterilisations, the packing and other towels used in operations for over 60,000. No less than 180,000 swabs or artificial sponges are sterilised every year.

ACCESSORIES

Instrument trays are essential. They should be made of glass or porcelain.

The trays should be sterilised by boiling water before use.

The instruments should be arranged neatly in one or more trays, and should be classified—*i.e.* the cutting instruments in one part, the forceps in another, the scissors in a third.

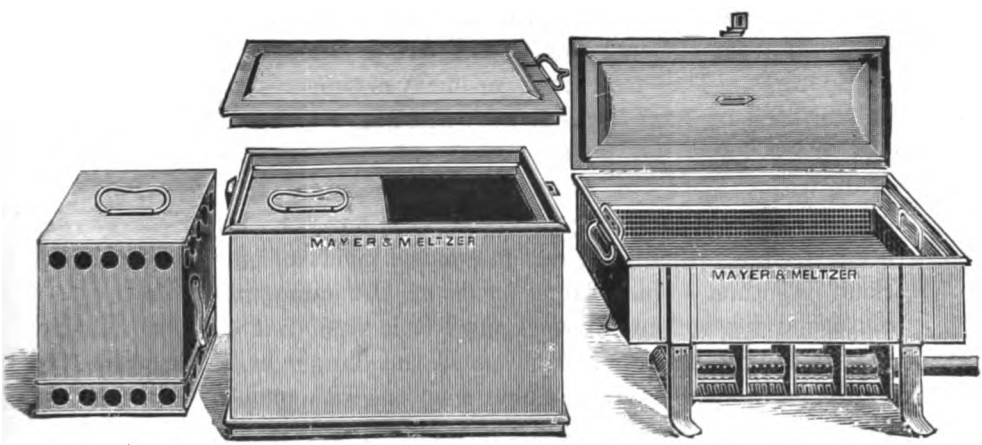

FIG. 23.—PORTABLE STERILISER FOR INSTRUMENTS, DRESSINGS, ETC.
Heated by Bunsen burner or special spirit lamp.

If a great number of pressure or clamp forceps have to be at hand, they may be conveniently placed in a tumbler or in a small glass receptacle with steep sides. This enables them to be well displayed, and prevents them from becoming entangled.

The trays, basins, etc., are filled with sterilised water, and in this the instruments remain immersed. Some operators prefer to keep their instruments dry in the trays, and there

are obvious advantages in this method, which is safe provided that they have been thoroughly sterilised first. In any case the use of strong antiseptic solutions in the trays is needless and should be avoided.

In a few operations irrigation is required, and then a large conical glass irrigator, with a tube of good lumen and a suitable tap, is the best apparatus. The whole apparatus, as well as the contained solution, must of course be sterilised.

A syringe is to be condemned. It is awkward to use, is apt to get out of order, involves much waste of time, is difficult to keep clean, and sends upon the wound surface an ill-regulated, spasmodic, and usually too violent stream of water.

The most convenient receivers are made of glass, and the most useful form is that known as the "kidney shape."

The receiver is held beneath the wound surface, and receives the fluid from the irrigator or the wrung-out sponge.

Sponges.—The fact that ordinary sponges cannot easily be sterilised by heat has led, with most surgeons, to their complete replacement by pads or swabs of gauze which can be so dealt with. Masses of absorbent wool, encased in little gauze bags, or square pads of gauze (several layers thick), are widely used. A few stitches are run round the layers of gauze to hold them together. Much larger pads of the same materials are employed for abdominal work, and it is well that each should have a long tape attached to avoid the danger of leaving one in the peritoneal cavity. Some surgeons use pads of Gamgee tissue. At the same time a good Turkey sponge is very convenient, and the difficulty of rendering sponges aseptic is not insuperable.

New sponges must be carefully cleaned and freed from every particle of sand. This is effected by having them well beaten and shaken in calico bags, and then by immersing them for some twenty-four hours in warm water, in which also they should be frequently rinsed out.

Steaming or boiling sponges in water ruins them, but there is a method of sterilising them by heat which is effectual. They

are soaked for one hour in a 40 per cent. solution of formaldehyde (a most powerful germicide, which alone is probably sufficient), and they can then be boiled for several minutes in water without shrinking or losing their elasticity.

The following alternative method is, however, quite safe, and dispenses with the boiling. The sponges, after thorough mechanical cleansing, are kept in wide-mouthed and tightly stoppered glass bottles full of ethylic alcohol in which one part of pure carbolic acid to twenty of the spirit is dissolved. Sponges thus kept shrink greatly owing to the alcohol, and thus enough for an ordinary operation can be preserved in a small bottle. Before use they are wrung out and soaked in warm sterilised water, when they assume their natural size and texture. By this method they can be used again and again with perfect safety.

CHAPTER V

ELEMENTS OF OPERATIVE SURGERY

Arrangements of the Operating Table.—The surgeon, before he takes the knife in his hand, should have very clearly made up his mind not only what he intends to do, but also how he intends to do it. In like manner, he should precisely instruct his assistants as to their duties and the manner of performing them. Each man should have his place and his especial office, and to this he should devote his whole attention.

The patient should be placed in the most convenient position. The part to be operated upon should be well exposed. The rest of the body should be neatly and carefully covered up, and should be surrounded by precisely folded towels. Not one particle of blanket or of flannel should be visible. The "fluff" of these materials readily comes off on the wet hand, and is easily picked up by the instruments. Thin mackintosh sheets covered with sterilised towels should form the only material with which it is possible for the fingers or the instruments to come in contact. All towels used should be taken straight out of the metal boxes in which they have been sterilised. We have found it most convenient to employ two kinds of towel, large thin ones and miniature bath towels, the latter about eight or ten inches square. These small ones are used as packing, and are both more convenient and more economical than pads of wool or Gamgee tissue. Such pads are always thrown away, and in a busy operating theatre their expense is heavy; whereas the small bath towels can be washed, sterilised, and the same ones used for a year or two. Surgeons differ as to whether the towels should be used moist or dry; we prefer the former,

wringing them out of sterile hot water immediately before applying them round the operation area.

In the most convenient place below the site of the operation two or more of the small absorbent towels should be wedged, so as to absorb any blood which may gravitate from the wound. They should be changed as often as required. In the case of an excision of the breast, for example, the packing may be wedged under the posterior margin of the axilla, and between the thorax and the mackintosh covering the table. In the case of an operation for hernia or a castration they should be placed against the perineum. By adopting this plan, blood cannot trickle beneath the patient's back or limbs, and much time is saved, on the completion of the operation, which would otherwise be taken up in cleaning the dependent parts of the body.

Every detail should be arranged as tidily, as clearly, and as methodically as possible.

Each instrument should have its proper place in the instrument tray. The operator should not rinse his hands in the solution contained in the tray, nor dip swabs or sponges in it. If common care be not exercised, it is possible for the solution to become so opaque that the instruments cannot be readily identified.

A basin containing warm sterilised water should be placed on the instrument table, so that the surgeon can cleanse his hands rapidly from time to time.

The wiping of blood-stained hands upon a dry towel is neither an easy nor a satisfactory method of cleaning them.

The assistant should take every care that all blood issuing from the wound is sponged up at once. If this be not done, blood may cover everything, and may be carried about by one and another over the whole field of the operation. Small instruments, moreover, may be lost among the clots which accumulate below the wound, and the necessary manipulations of the operator are carried on in an atmosphere of sticky uncleanness. An active assistant may make any ordinary operation

appear almost bloodless, and his efforts will not end with appearances merely, but will conduce to that precise cleanliness which is so essential in connection with an operating table, and to that "clear field" which is so much prized by the neat operator.

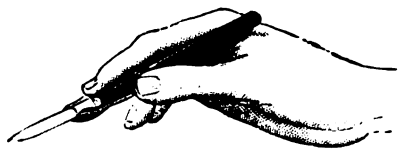

FIG. 24.

As each instrument is used, it should be returned at once to its proper place in the tray. In no circumstances should instruments or receivers, etc., be rested on the patient's body.

The making of the wound.—The question of the precise manner in which the scalpel or knife should be held in making an incision must be left, to a great extent, to the taste and custom of the individual operator. In making the lightest and finest incisions, as in exposing an artery and in some plastic operations, it is well that the scalpel should be held between the thumb and the fingers like a pen, the thickest part of the handle being the part grasped (Fig. 24).

FIG. 25.

If more power be required, the scalpel may be held somewhat as a violin bow is held, in the position shown in Fig. 25.

"This method," as Fergusson observes, "requires great steadiness naturally, but with practice, much ease, elegance and dexterity may be displayed when the knife is thus held, and even the most minute dissections may be effected with the hand and scalpel in the attitude here represented."

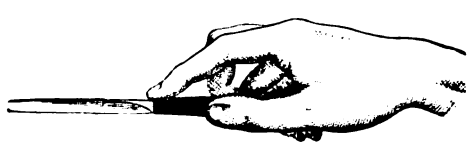

FIG. 26.

In the making of cuts requiring still more power, such as ordinary skin incisions, and in the handling of instruments larger than the scalpel, the knife may be held in the manner of a

dinner knife, with the fore-finger upon the back of the blade (Fig. 26).

In operating, the fact should never be lost sight of that the best wound is a clean incised one, and that a lacerated or contused wound is a blemish on the work of the operator.

It is important also to bear in mind that the usual operation wound is not limited to the skin ; it extends into the depths of the part operated upon. The wound should be an incised one, whenever possible, throughout its whole extent. The skin may have been divided by a clean cut, while the deeper tissues may have been severed by needless tearing and laceration. Defects in healing are more often met with in the depths of a wound than in the integumentary part of it.

Each cut should be made cleanly and precisely, and with as much care and deliberateness as an engraver would bestow upon each movement of his tool. In a skin incision the wound should be as complete at its two extremities as at its centre. It should be of even depth throughout, be well finished, and present no " tails."

The depths of the wound should not be *torn open* with the fingers. The fingers are useful enough and necessary enough in opening up the depths of some operation wounds, especially when ligaturing arteries. The fingers answer perfectly for separating some muscles, as in exposing the anterior tibial artery ; but, while intermuscular spaces are conveniently opened up with the fingers, muscle tissue should never be torn through by them. Many tumours are enucleated almost by the fingers alone ; but, in general terms, it may be said that the more that is done with the scalpel and forceps the better.

There is a great disposition towards the needless and reckless use of the " handle of the scalpel." Those who would employ this means in such an operation as the exposure of an artery would incise the skin in the usual way, and would then attempt the rest of the operation (so far as the reaching of the vessel is concerned) with the forceps, the fingers, and the handle of the scalpel. A moderate use of both finger and handle of scalpel

or dissector (*see* Fig. 6) is well enough, especially when a search for a deep artery is being made, but the moderation must be within the narrowest limits.

A perfectly needless degree of injury may be inflicted upon the tissues by this uncouth method of operating; parts are lacerated and displaced, and the anatomical details of the region are rendered obscure. It is a method which finds favour alone with those who use a scalpel with fear and with unsteady hands, or who have but a confused idea of the topography of the district which they are so roughly invading.

In certain operations blunt dissection by means of forceps and dissector alone is invaluable, such, for example, as at that stage of the operation for the radical cure of hernia in which the vas deferens and vessels require to be peeled off the sac of peritoneum. It is almost needless to say that in this manœuvre the forceps are used with care not to damage the thin vessel walls. In removing glands from the neck the free use of the scalpel instead of the blunt dissector may be dangerous.

There remains, however, one method of extending an operation wound which yields to none in intrinsic badness. It is the method represented by the use of the *director*. The art of operative surgery would benefit greatly if the director were to be almost entirely banished from the list of surgical instruments. A director is certainly of service in operating upon fistula, in dealing with sinuses, in disposing of some false membranes about the viscera, and in herniotomy. In herniotomy, however, it is used only when the stricture is being divided, and serves to save the bowel from the undue pressure of the finger. A surgeon who cannot cut down upon an artery, or expose a hernial sac or a subcutaneous cyst, or who cannot reach the transversalis fascia in the loin, without the use of a director, had better abandon operating. The liberal employment of a director is a demonstration of inefficiency, and the long list of special directors is not creditable to surgical progress.

In exposing a deep part, such as the sac of the hernia, the whole process should be effected by clean incisions. The knife

should follow the same precise line, and be carried neatly from one end of the wound to the other.

The layer of tissue next to be divided should be carefully picked up with the forceps, and the piece so held may be gently moved from side to side, in order that its density, its thickness, and its freedom from deeper connections may be made out. Now and then, in approaching a hernical sac, the tissues may be pinched between the finger and the thumb, so that the thickness of the remaining layers may be estimated, and the position of the contained bowel or omentum defined.

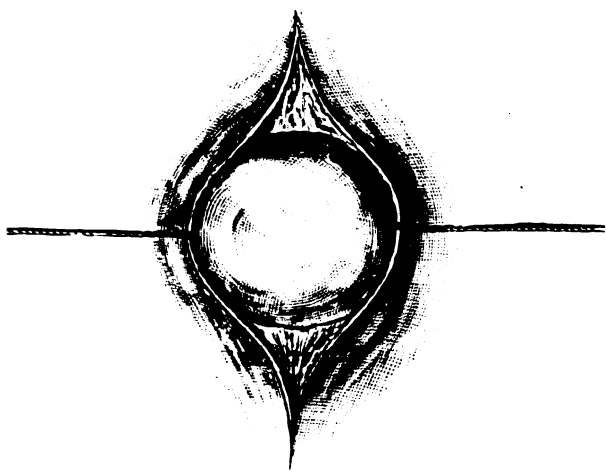

FIG. 27.—MODE OF EXPOSING A TUMOUR BY LIGATURE OR THREAD RETRACTORS.

It is desirable also that the margin of the wound should not be bruised or damaged by uncouth retractors. The simple wound-hooks and the wound-retractors described already (page 48) effect the least disturbance of the divided tissues and make the least encroachment upon the field of the operation. Retractors of all kinds, however, must be used with a light hand.

In performing many small operations we make use of what may be termed *ligature retractors*. After the incision through the skin and the subcutaneous tissues and fasciæ has been

made, the margins of the wound are held aside by means of silk ligatures, which are inserted close to the cut edge on each side (Fig. 27).

These ligatures occupy no room, interfere in no way with the surgeon's movements, and do not encroach upon the field of operation. They should be of considerable length, so that the assistant who holds them may be well out of the way. When they are employed upon a limb, one of the threads may be passed under the limb, so that one assistant can hold both threads upon the same side of the extremity.

These retractors are very useful in any operation for the removal of superficial tumours—*e.g.* in dissecting out a diseased bursa patellæ. The edges of the wound can be kept separated to the utmost extent throughout the operation. In performing the radical cure for varicocele, also, no better means can be found of retracting the scrotal tissues, while the veins are being exposed, than is afforded by these threads. In such an operation as that required for the ligature of the lingual artery, the edges of the wound can be admirably separated by silk retractors, which have the merit of never slipping and of occupying no appreciable space. Pressure forceps are of considerable use as retractors, especially in deep wounds, when these instruments may be employed to hold up and draw aside the margins of a divided deep fascia.

It is desirable also in *all* cases that the incision should be long enough for the purposes of the operation. The attempt to evacuate a tumour through the smallest possible incision often involves a considerable bruising and laceration of the edges of the wound in the attempt to drag or squeeze the mass through the narrow opening.

A long, cleanly incised wound is always to be preferred to a shorter wound with contused margins.

Surgeons who boast of the smallness of their incisions are proud of what is at best but a questionable feat. While it is most essential that a wound should never be larger than is necessary, at the same time it is important that the operator

should have a good view of the parts with which he is dealing. There can be no possible object in attempting to ligature the common carotid through an incision an inch long. It can be done as a feat; as a surgical procedure it involves much cutting in the dark, and adds a quite unnecessary danger to the operation.

In performing operations upon the abdomen especially is it desirable that the parts to be dealt with should be well exposed; and to attempt to gauge the manipulative skill of an operator by the smallness of his laparotomy wound is often to attempt a criticism upon false premises.

Arrest of Bleeding.—The sponging of the wound requires a little care. The "sponge" should be as little wet as possible, and should be applied to the surface with a quick, firm, decisive touch. There should be no patting of the wound, nor should the sponge be roughly rubbed over it or swept heavily across it. Rough sponging cannot do other than injury to soft tissues, besides being inefficient.

The bleeding surface should be well exposed, and bleeding points should be seized with the pressure forceps as soon as they are detected. It is needless to say that the larger vessels should be secured first. Pressure forceps are of necessity used in haste as a rule, but every care should be taken to grasp the vessel neatly and completely, and to include no more tissue than is absolutely necessary between the blades of the forceps.

To grasp a large mass of tissue about a bleeding point, and to allow the forceps to compress it with the full force of the spring during any considerable period of time, is obviously bad. The structures so dealt with are needlessly crushed; and it may be no matter of surprise if they sometimes slough. If in the hurry incidental to copious hæmorrhage the tissues are somewhat recklessly seized, the forceps should be readjusted with more care as soon as the urgency is over.

Simple oozing will usually yield to mere exposure to the air, to the effect of a few seconds of time, to the pressure of

a nearly dry sponge, or to the action of hot water. In certain cases a solution of adrenalin is most effectual.

Small vessels need only the treatment involved by the continued pressure of the forceps. The longer they can be left on the better, and if then they are carefully removed, the artery will usually be found to have ceased to bleed.

Vessels a little larger than those alluded to may usually be dealt with by torsion. No special torsion forceps are required. If the artery has been neatly and cleanly picked up by the point of the pressure forceps, it can be occluded by torsion without removing the forceps. The vessel should be drawn well out, and the instrument then twisted round three or four times between the fingers and thumb, until there is a sense of lack of resistance.

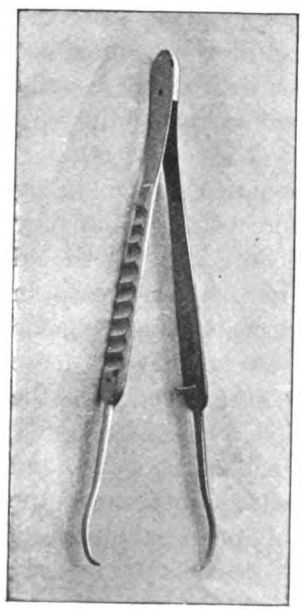

FIG. 28.—TENACULUM FORCEPS. (London Hospital Pattern.)

In dealing with the larger arteries, and with main vessels, a catgut or fine silk ligature must be used. The vessel, while yet the pressure forceps occlude it, should be gently isolated and securely ligatured.

In the case of free bleeding from one or more points upon a surface, continued pressure—to be maintained in the subsequent dressing of the case—is the simplest measure.

In instances in which such pressure cannot be applied, the bleeding point may be picked up with a tenaculum (Fig. 28), and then secured by silk. Silk is the material that of all others is most likely to retain a hold of the tissues under these conditions. The thread should be applied in a well and fully tied "surgeon's knot" (page 53).

It should be an element in the dressing of operation cases

that substantial pressure is kept up in order to control any continued disposition to bleed. For this purpose one or two folds of elastic bandage outside the main dressing will be found most useful.

Closure of the Wound.—In previous sections the question of the selection of a suture material and of suture needles is dealt with, and the manner in which sutures are to be secured is described (page 53).

Before introducing the sutures, the wound should be most carefully cleaned and its edges accurately approximated. It is most desirable that the margins of the wound should be well defined, and that in uniting it parts which were in contact before the operation should be once more brought into apposition. As

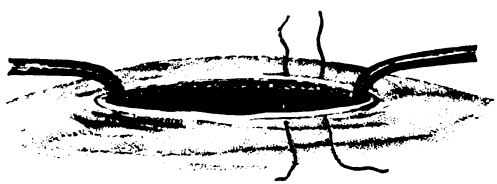

FIG. 29.—METHOD OF STEADYING THE MARGINS OF A WOUND WITH BLUNT HOOKS DURING THE INTRODUCTION OF THE SUTURES.

the tissues left after the removal of a tumour or the reduction of a large hernia are lax, and the integument is flabby and in folds, it is easy for the wound to be irregularly united, and to be puckered in one place and drawn too tightly in another.

In all but the smallest incisions, therefore, the edges of the wound should be put upon the stretch, and be so adjusted to one another that they form when in contact a simple line. This is effected by introducing a slender blunt hook into each angle of the wound in the manner shown (Fig. 29), and by then drawing upon the hooks until the wound margins are parallel and are approximate to one another. These hooks are almost indispensable in the closure of certain abdominal wounds. They not only keep the wound edges steady and in accurate line, but they also keep the parietes (at the seat of the wound) away from the underlying viscera.

The needle should be introduced as close to the free edge of the wound as is consistent with a good hold upon the tissues. If the suture be applied too near, the hold obtained is slender and the thread is apt to cut through. If it be inserted at too great a distance from the wound, the margins of the incision are liable to become turned in upon one another.

In closing large wounds, and in inserting sutures which will be exposed to strain (as in wounds of the abdomen, deep wounds of fleshy parts, and amputation flaps), it is well to place the main sutures at some distance apart (about three-fourths of an inch), and some way (about three-eighths of an inch) from the edge of the wound. A very good hold is thus obtained upon the tissues. Between these main sutures smaller secondary sutures are inserted, which are introduced close to the margin of the wound.

In subsequent chapters special details are given as to the method of closing particular incisions (*vide* Abdominal Section, etc.).

Sutures are probably more often drawn too tightly than tied too lightly.

In using silk the knot should be so placed as not to press upon the skin at the needle aperture.

The sutures described unite merely the skin-cut, and it must be remembered that in an operation incision this skin-wound forms the least part of the lesion. The ***main wound***, represented by two large raw surfaces, lies beneath the integument. Although the sutures may close the cut in the skin efficiently, they may leave the depths of the wound unaffected, and while the minor surface incision is perfectly adjusted, the great wound, which spreads deep into the tissues, remains gaping.

In placing the parts in the best position for healing, the union of the severed tissues beneath the surface and *the obliteration of the wound cavity* become matters of the first importance. It is with the greater lesion that the surgeon should concern himself, rather than with the mere cut in the skin.

In wounds which are not of too great a depth this end is secured by using a circular needle to carry the suture and by passing this needle carefully through each layer of the divided tissues, commencing with the skin and ending with the last layer cut.

The layers are picked up one by one in precise order, and in such a way that the needle passes close to the margin of the cut in each layer.

These deep-passing sutures need not be placed very close together, and in the gaps between them the skin may be united by superficial sutures of silk or catgut or fine silkworm gut.

In wounds involving extensive deep surfaces, such as are left after the removal of a large tumour, regular and unremitting pressure must be exercised over the whole wound area as the stitches are being introduced. Until the wound is closed and drained—if a drain be needed—this pressure is maintained by sponges (natural or artificial), and when the suturing is completed the dressing is so applied as to maintain the firm and even pressure exercised by the sponges.

In these cases and in the case of amputations, this pressure, very cautiously and discreetly applied, serves to keep the raw surfaces of flaps in perfect apposition, to obliterate any space which may exist between them, to prevent any after-oozing of blood, to squeeze out any blood which may still be present, and to allow no cavity to exist in which an accumulation could take place.

Buried Sutures.—In certain regions and in certain operations buried sutures are of great use, and can hardly be dispensed with. We may instance the radical cure of inguinal hernia, where the canal is opened up, abdominal section on a stout patient, the removal of the vermiform appendix, etc. It is true that silkworm-gut sutures, if passed through all the divided tissues (*i.e.* to the bottom of the wound), and if left in a full fortnight, will leave a deep scar which may not yield.

But deep sutures, provided their material is non-irritating and they are aseptic at the time of introduction, are more sat.s-

factory. Many operators rely on silk for the purpose, some on chromic catgut, others on cellulose threads, some on ordinary catgut.

For suturing the peritoneum so as to leave a smooth surface which shall not invite adhesions of intestine to it, we consider a continuous suture of catgut the best. For bringing muscular or aponeurotic tissue together we strongly recommend kangaroo tendon (interrupted sutures). Fifteen years' experience of the tendon, during which time we have buried many thousands of such sutures, has proved that it is an extreme rarity for any inconvenience to result. That now and then a buried tendon suture acts as a foreign body and sets up irritation we do not deny; but this tiresome complication is far more frequent in the case of buried silk.

As to the use of buried silver wire in abdominal operation wounds (a practice in vogue with some American surgeons), we can imagine no material less suitable. With regard to amputations, we see no reason for the use of a number of buried sutures; silkworm gut, made to penetrate deeply from the skin, answers admirably.

Removal of Sutures.—The length of time during which surface sutures may be *retained* cannot be arbitrarily stated. Those of silk soon cause irritation, and if not removed within a certain time are apt to produce sutural abscesses. From six to eight days will approximately represent the limit of time during which such sutures may with safety be retained.

With silkworm-gut sutures the case is different. They may be allowed to remain in the wound for ten or twelve days, and in the operation for the closure of a cleft palate they may be left in for longer, if necessary. As a general rule, sutures—or, at least, the main sutures—should be removed on the eighth day.

When a wound is of no depth and of very simple character, either an ordinary continuous suture of catgut or a subcuticular one of the same material may be employed. The one advantage is that it is unnecessary to "take out the stitches" later,

a proceeding of which some patients have an unreasonable dread.

Draining of the Wound.—For the great majority of operation wounds no drainage arrangement of any kind is required. The great essential in dealing with a wound is, as already said, to bring all parts of the cut surfaces together, and to obliterate the wound cavity. If this be efficiently done, there is no place in which exudations can accumulate and no area to drain.

If, on the other hand, the margins of the skin wound are very closely united while the depths of the incision are left unheeded, then it will often happen that a closed subcutaneous cavity is left, into which exudations from the divided tissues may flow, and from which they have no way of escape.

If a cavity be quite unavoidable, then a drainage tube must be inserted; but if no cavity exist, then the tube serves merely to separate the cut surfaces and to impede their speedy union. The really aseptic and well adjusted wound and the drainage tube are quite incongruous.

From large wound surfaces, such as are left after an amputation or the removal of a tumour, a not inconsiderable oozing of blood and serum may be expected. The escape of this is encouraged by the pressure which is maintained upon the parts, by not introducing the sutures too closely, and by leaving some gap between them at the most dependent part of the wound.

Should these means appear inefficient, then a tube may be inserted, and removed in twenty-four or forty-eight hours.

In many cases where pressure cannot be well applied—as in some parts of the neck—and where gravity does not aid the escape of exudations, and where also a neatly adjusted skin wound is a matter of importance, a drain may be introduced. But in such cases there very rarely remains any excuse for retaining it for more than twenty-four, or at the most thirty, hours after the operation.

The following are instances where drainage may be serviceable:—

(*a*) When a cavity is produced at the bottom of which tissue is exposed that could not be expected to join in a normal healing process. This is a condition met with after some resections of bone, after some operations upon diseased joints, and after the partial removal of cystic growths.

(*b*) When there is, or is likely to be, a considerable oozing of blood, as in incomplete operations for the removal of growths.

(*c*) When sinuses or inflamed districts are opened up in the course of the operation, and when the involved tissues are not excised but are allowed to remain, in whole or in part. This is illustrated by an amputation for disease, where an old sinus occupies the substance of a flap, or the track of a sinus is exposed in the depth of the stump. Although these sinuses may have been well scraped, they can scarcely be expected to take a wholesome part in the healing process.

(*d*) When much-damaged tissues are left in the depths of a wound, as in cases where deeply-attached tumours have been removed with great difficulty, and with much bruising and laceration of the soft parts, and the application possibly of many ligatures. In such cases the insertion of a drainage tube is a wise precaution.

(*e*) When an operation has been performed upon an œdematous or infiltrated part, it is inevitable that much oozing will occur during at least the first few days, and this should be allowed to escape freely. In a case therefore of amputation, where the flaps are formed out of tissues which are still œdematous, a tube may be employed to give free vent to the fluid which will ooze from the cut surfaces.

(*f*) Drainage may be employed in cases when the wound is septic at the time of the operation, in some operations near the anus, and in instances where a fistula is inevitable, as after certain operations upon the bowel, kidney, etc.

(*g*) A gauze drain may be inserted as a precautionary measure after suture of the bladder or ureter, etc., when leakage is possible, though not certain.

The following are some of the methods of securing drainage which are suitable for different cases :—

1. Where slight oozing is expected, but where it is desirable to leave the dressings unchanged for several days, a few strands of catgut are inserted side by side.
2. A piece of sterile ribbon gauze is rolled lengthways, one end being left out of the wound.
3. A spiral rubber tube is employed. This admirable drain, very flexible and non-irritating, is made by slitting up a red rubber tube into two halves. One of these is rolled spirally. These tubes can be obtained of all sizes, but the small ones are most useful (Fig. 30, *a*).

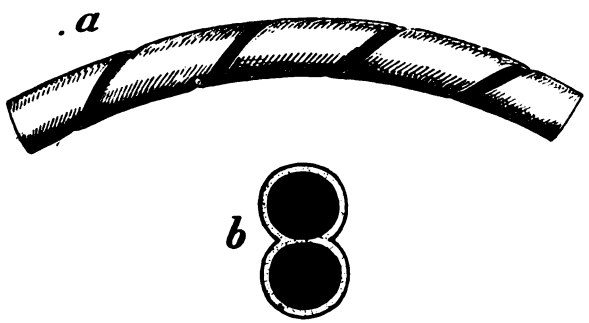

FIG. 30.—(*a*) SPIRAL RUBBER DRAINAGE TUBE; (*b*) DOUBLE OR TWO-WAY RUBBER TUBE.

4. The ordinary rubber tube is most employed for suppurating cavities, including the peritoneal one. Where irrigation is intended to be used a double or two-way tube is appropriate—*i.e.* two tubes are fastened side by side (Fig. 30, *b*).
5. Cotton wick may be inserted inside a rubber or glass tube.
6. Glass drains are sometimes employed in abdominal work, especially to allow fluid to escape from Douglas's pouch above the pubes. Their supposed advantages are somewhat doubtful.

On Local Analgesia as a Substitute for General Anæsthesia.—The subject of general anæsthetic administration is too large and specialised for discussion in this place. Moreover, provided that a skilled anæsthetist has been obtained for an operation, the less the surgeon interferes with his choice of anæsthetic and methods of giving it the better it will be, as a rule, for both parties. The operating surgeon is responsible for all the details of the operation itself, and for asepsis being secured throughout its performance. He should be entirely free from all care or responsibility for the patient being well and safely anæsthetised.

In a large number of operations, however, a general anæsthetic may be dispensed with in favour of local analgesia. This applies not only to minor procedures such as circumcision, amputation of fingers, excision of subcutaneous tumours, and the like, but also to certain major operations in which the patient's condition or other circumstances cause especial risk if ether or chloroform be given.

Cocaine is far from being a safe drug to employ for the purpose, whilst β-eucaine, combined with adrenalin, is both more effective and a very safe local analgesic if injected in moderate doses. Up to six grains of β-eucaine may be thus used on an adult patient. The formula for the solution is given by Mr. A. E. Barker * as follows :—

β-eucaine, 6 grains (.4 grammes)
Sodium chloride, 24 grains (1.6 grammes)
Solution of adrenalin (1 in 1,000 of normal saline solution), 20 minims
Distilled water, 7 ounces (200 c. centimetres)

The strength of this solution is about 1 in 500 of β-eucaine and 1 in 200,000 of adrenalin. Half the quantity mentioned—*i.e.* 3½ oz.—will suffice for most operations. The solution is best freshly prepared in the following manner (the directions are

* *Brit. Med. Journ.*, Dec. 24th, 1904.

from Mr. A. E. Barker's valuable paper): Seven ounces of distilled water are boiled in a Jena glass beaker, or wide-mouthed flask; 6 grains of β-eucaine and 12 grains of pure sodium chloride are then dissolved in the water, which is now allowed to cool to blood-heat or thereabouts. Twenty drops of the ordinary sterile saline solution of adrenalin are added to the solution, which should be used at the body temperature. The syringe and needles should be sterilised by boiling in distilled water; any trace of soda or other alkali may spoil the action of the adrenalin. Mr. Barker recommends for deep injection the use of Freienstein's needles, five inches long, with the addition of a fine rubber case made of the smallest Jacques catheter, the rubber being tightly fitted on to the needle.

The addition of adrenalin to the eucaine solution has the following effects: (1) It constricts the arterioles of the part, and hence checks hæmorrhage during the operation; (2) it delays the production of analgesia for a considerable time, hence the injections should be made thirty minutes before the operation is to be commenced; (3) it prolongs very greatly the duration of the anæsthesia and analgesia, which may last for two or three hours.

The injections are made into the subcutaneous and intermuscular planes, etc., and when possible they should also be placed on the proximal side of the sensory nerves supplying the part to be incised. As already stated, the warm solution should be injected at least half an hour before the operation; at the end of this time much of the artificial œdema (which is such a drawback to the older methods of local anæsthesia) will have disappeared.

For rectal operations—removal of hæmorrhoids and the like—local anæsthetics are, as a rule, inadequate and unsuitable. The absorption of the drug cannot be controlled; many unfortunate accidents have occurred, and the analgesia is almost always imperfect.

Further reference to the use of eucaine in abdominal and such operations, etc., will be found in the sections relating to them.

Intraspinal injections of eucaine or stovaine have been extensively practised for abdominal operations and those on the lower limbs, especially on the Continent. In this country Mr. A. E. Barker and Mr. H. P. Dean have published articles dealing with this subject, on which the foreign literature is most voluminous.

The Technique of Spinal Analgesia.—Of the many drugs used for the purpose—eucaine, tropacocaine, novocaine, alypin, stovaine, etc.—stovaine appears to be as safe as any, and has come into the widest use. From ¾ to 1 grain, dissolved in about 30 minims of water, injected within the dural sheath between the third and fourth lumbar vertebræ, will produce sufficient analgesia for almost any operation on the lower limbs, the lower part of the abdomen, and its viscera, etc.

Stovaine in the appropriate dose—5 centigrammes or ¾ grain—is supplied in small sealed glass tubes, which are sterilised by heat. It is merely necessary to break off one end of the tube and draw the fluid into the syringe. Special forms of syringe are on the market, Mr. Barker's pattern being an excellent one. The cannula-needle must be long, fitted with a stylet, and made of non-corrosive metal (pure hard nickel is the best).

The patient sits up on the table and arches his spine backwards. The skin over the mid-lumbar region is rendered aseptic; a line is mentally marked between the highest points of both iliac crests. This crosses the fourth lumbar spine as a rule, and the needle should be plunged in just above this, the middle line being marked between finger and thumb of the left hand. Owing to the overlapping of the lumbar spinous processes, it is essential that the patient should bend well forwards so as to separate these and allow the cannula to slip between them. The patient should hold his breath and strain in order to distend the sheath. The intradural space should be struck at a depth of about 2½ inches, when clear cerebro-spinal fluid will escape. Unless this happens it is useless to inject the stovaine, as the end of the cannula cannot be in the subdural space. After a little of the fluid has escaped the syringe is

attached to the cannula and the stovaine solution slowly injected. A small pad of gauze with collodion is used to seal the wound after the cannula has been withdrawn, and the patient lies back with the upper part of the trunk supported on pillows. It is, of course, obvious that if high anæsthesia is required the shoulder region should be lowered, or even the pelvis raised; but the latter manœuvre is certainly dangerous. M. Hartmann, of Paris, who has had a wide experience of spinal analgesia in major operations, records two sudden deaths in his own practice from the fluid being carried up to the medulla by elevation of the patient's pelvis (*Bull. de la Soc. de Chir.*, March, 1908, where a valuable discussion on intraspinal injections and their risks will be found). Throughout the operation, and for some time afterwards, the patient's head and shoulders *must be kept raised* on a pillow.

The anæsthesia is complete in a few minutes, and lasts from half to one hour. If necessary, a second injection of stovaine, half the dose of the former one, may be administered. This, however, would be inconvenient and sometimes impossible whilst the operation is in progress; it can very rarely be required. Even operations on the upper part of the abdomen, such as gastro-jejunostomy, can be carried out under spinal analgesia. Mr. Barker recommends a "heavy injection"—*i.e.* the solution of stovaine has added to it 5 per cent. of glucose.

The reader is referred to two papers on the subject by Mr. Barker (*Brit. Med. Journ.*, March 23rd and Feb. 1st, 1908), in which 200 cases are summarised. He introduces the syringe with the patient in the lateral recumbent position, as a rule.

Advantages of spinal analgesia.—The method is strongly indicated where a general anæsthetic would be dangerous, or where postanæsthetic vomiting is specially to be avoided; for example, a case of strangulated hernia in a bronchitic patient or one of suppurative peritonitis. It is claimed for it that the shock of an operation is much less than with a general anæsthetic.

Disadvantages.—Spinal anæsthesia is unsuitable for operations on children. There is sometimes much difficulty met with

in introducing the needle into the spinal theca. Failure to obtain satisfactory analgesia was recorded in 20 of Barker's 200 cases—*i.e.* 10 per cent. There was no direct mortality in this series, but undoubtedly fatal accidents have occurred, and one American surgeon from a collection of over 2,000 cases made out a mortality of no less than 1 in 150. It should, however, be noted that stovaine is far safer than cocaine and other drugs that were employed at first.

We have seen troublesome pain in the lower limbs supervene after spinal analgesia, a neuralgia lasting perhaps for two or three days. Incontinence of urine or fæces is an occasional sequela of spinal injection. Faintness, nausea, or actual vomiting are not very infrequent after it, but these symptoms are rarely troublesome, and may be combated by caffeine injections, stimulants by the mouth, etc.

It is as yet too early to decide on the comparative merits of spinal and general anæsthesia in routine operating work. A few surgeons, such as M. Guinard, of Paris, after a long trial of the former, have entirely abandoned it on account of the risks, but this has not been the general experience. It has been employed in so many thousands of cases that the drawbacks cannot be very serious, and certainly it will continue to be employed where a general anæsthetic is not suitable.

Prof. Bier, of Bonn, was one of the first surgeons to employ it, in 1898, and his experimental work has done much to develop the method and bring it into general adoption.

CHAPTER VI

AFTER-TREATMENT OF THE WOUND

IMMENSE progress has been made of late years in the treatment of wounds. In this progress the most prominent figure is that of Lord Lister. To him will ever belong the honour of having effected a reformation in surgery, of having established upon a new and scientific basis the ancient art of healing, of having freed the operator from the more grievous of the dangers which surround him, and of having greatly extended the powers and possibilities of the surgeon's art.

As to the exact method of dressing a wound, and the materials to be used in that dressing, it is impossible to be dogmatic.

All surgeons endeavour to secure that the wound shall be quite clean; shall be aseptic; shall not be irritated; shall be kept at rest. One surgeon accomplishes these ends in one way, another in another, and the results are equal. He who considers that his method of dealing with a wound is the most perfect will find that his neighbour, who adopts very different details, obtains an identical measure of success.

New antiseptic agents appear from time to time upon the scene. They are pursued, are vaunted as perfect, are diligently employed, and then not a few of them fade away, some very gradually, others with the suddenness of the South Sea Bubble.

In the after-treatment of the operation wound the part must be kept absolutely at rest. Mere confinement in bed, with the support of a proper pillow, may suffice to effect this, or a special splint or retentive apparatus may be employed.

When convenient—*e.g.* in the case of an amputation or excision—the part should be kept raised, so that the circulation of the blood through it may be as much relieved as possible.

In the exceptional cases in which drainage of the wound has been required—*e.g.* in perityphlitic abscess—the position of the patient should be arranged to favour this.

Long conflict of opinion as to the best material for the first dressing of wounds has resulted in practical uniformity. Plain sterilised gauze, or gauze impregnated with double cyanide of mercury and zinc, is used almost universally. Whether it should be applied moist or dry is not a matter of importance, but we suggest that the folds nearest the skin should have been wrung out of warm water or weak carbolic solution. It thus furnishes a softer and more adhesive surface than the dry gauze. Sterilised wool is placed over this, so as to provide equal pressure over a considerable surface. There must be few surgeons now so misguided as to dust iodoform powder on to their operation wounds in the belief that it can prevent or diminish suppuration.

A bandage is then so applied as to bring pressure to bear upon the wound. The effect of this is that the edges of the incision are kept well together, the cavity of the wound is obliterated, any tendency to oozing is prevented, the use of a drainage tube is rendered unnecessary, and the parts concerned in the wound are kept perfectly at rest.

The "domette" bandage is best suited for the majority of cases. The bandages used are often unnecessarily thick, and hence in hot weather uncomfortable. Those made of thin "butter-cloth" muslin are very light and cool. For fixing dressings on the head, neck, and many other parts they cannot be surpassed.

The amount of pressure employed must depend upon the circumstances of the individual case. Unlimited pressure would obviously not be employed in cases where the vascular supply of the part is slight and the patient very old. In certain regions —*e.g.* the groin—one or more turns of elastic webbing bandage over the ordinary one will be found useful for maintaining even pressure (Fig. 31).

The simpler wounds, such as those following the radical

cure of hernia, need not be disturbed for a week or more. If much oozing be anticipated in any case, the wound may be dressed at the end of twenty-four hours, and then left for four or five days.

From our experience an ideal dressing for wounds in which some oozing is certain to occur—*e.g.* excisions of joints—is afforded by a moist sterilised gauze bandage. The bandage is not one thickness of gauze only, but specially made of three or four. This is dipped in weak carbolic solution, and applied directly over the wound, and made to cover the limb above

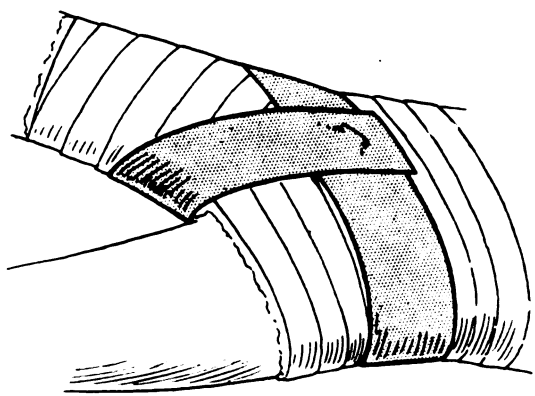

FIG. 31.—DRESSING COMPLETE AFTER RADICAL CURE OF LEFT INGUINAL HERNIA.
Over the plain bandage is applied a figure-of-eight turn of elastic webbing bandage, thus exerting even pressure over the site of operation.

and below for some distance. As the bandage dries it contracts, and therefore it must not be employed too tightly. Absorbent wool is applied outside this bandage, and secured with a second one.

The special advantages of this bandage dressing are: (1) Even support and pressure round the whole circumference of the joint or limb; (2) all oozing which occurs in the next twelve hours or so is readily soaked up by the moist gauze, whereas with dry dressing its escape might be impeded.

The wounded part should be kept in the open air—*i.e.* should be as far as possible uncovered by the bed-clothes. This

will be more or less inevitable with wounds of the head, neck, and upper extremity. The lower limb, after operation, should be quite uncovered by the bed-clothes. The atmosphere under bed-clothes is limited, is hot, is moist, and is frequently foul, as after the use of the bed-pan. The exposed limb may be wrapped up during the cold weather, and in our wards, where no wound of the extremities is ever allowed to be covered by bed-clothes, we never hear any complaint on the ground of the part being unduly cold. The patient's feet are encased in specially warm socks made of Gamgee tissue or the like.

We wish to call attention again to the value of the elastic webbing bandage in securing firm apposition of dressings, especially in such regions as the groin. If the patient be restless—and most patients are after an anæsthetic—no other bandage will answer the purpose unless it has been applied so tightly as to endanger venous thrombosis (which is no imaginary risk). The elastic bandage can hardly shift from position, and it accommodates itself to any movement of the patient. We have for many years employed it in every case of radical cure of hernia, of appendectomy, and in many others.

PART II.—ABDOMINAL OPERATIONS

CHAPTER I

ABDOMINAL SECTION

THE term abdominal section or laparotomy is applied to the opening of the abdominal cavity either for purposes of exploration and diagnosis or with the object of operating upon the abdominal or pelvic viscera.

Abdominal section implies the opening of the cavity of the belly at any point on the parietes, although in the great majority of instances the incision is made in the median line. As an operation *per se* it has no very distinct individuality. It is obvious that little in the way of definite treatment can be accomplished by the mere opening of the peritoneal cavity. It is remarkable, however, what unexpected effects have followed from a simple exploratory cut into the abdomen. In cases of tuberculous peritonitis the simple incision of the abdominal wall has a definite curative effect, which cannot at present be explained. More than that, substantial sarcomatous growths have undergone temporary diminution. Owing to the very fortunate want of special names, however, the term abdominal section includes the incision made for the evacuation of pus within the peritoneal cavity, for the relief of peritonitis by irrigation and drainage, for the reduction of certain internal herniæ, and the liberation of snared or adherent bowel, for the unfolding of volvulus, for the reduction of intussusception, and for other purposes of like character. The majority of abdominal operations have special names, such as ovariotomy,

gastrostomy, cholecystotomy, etc. It is important, however, to bear in mind that in all these procedures the major operation is the abdominal section. Abdominal surgery—in the sense in which the term is at present used—became possible as soon as it was shown by what means the peritoneal cavity could be opened with comparative safety, and the ordinary measures of surgical treatment applied to diseased conditions within its walls.

It is well that it should be borne in mind that there is nothing especial in this particular branch of surgery, and that no exceptional principles are involved in the details of the many operations which it includes.

Abdominal surgery represents merely the application of the common principles of operative surgery to the treatment of parts within the cavity of the belly. Although brilliant work in this direction had been done before the great discoveries of M. Pasteur and Lord Lister, it was only when sepsis could be prevented with certainty that the field of abdominal surgery became widely open to all. Its extension in the last twenty years has been marvellous, both in scope and in the success of its results. It is impossible here to assign due credit to each of the pioneers of abdominal surgery, especially as many of them are still living. But of those who are no longer alive it is safe to say that the names of Billroth, Spencer Wells, and Lawson Tait deserve all honour in connection with the surgery of the stomach, of ovarian cysts, and of the gall-bladder respectively.

Anatomical Points.—The skin over the anterior abdominal parietes is movable, the subcutaneous tissue is lax, and the amount of fat in that tissue is often considerable. The surgeon can soon learn from experience to form a fairly correct idea of the thickness of the integuments in the specific case under notice, and the length of the incision will have to be regulated to a certain extent by the depth of the soft parts. It is impossible to give any data as to the thickness of the anterior abdominal muscles, should the opening be made away from the middle line. The abdominal muscles of an athletic man and

those of a bedridden old woman can hardly be compared—they are different things. In all subjects some of the thickest muscle will be found above and to the inner side of the anterior superior spine, from which and the adjacent crest and Poupart's ligament radiate bands of the internal oblique and transversalis. Transverse division of muscle in doing abdominal section should be avoided as far as possible, since it is apt to leave a weak scar. In the most common abdominal operations—median section, radical cure of hernia, excision of the vermiform appendix, etc.—no muscle fibres need be divided, as a rule. Special methods of avoiding such division will be described in their appropriate place. It should be noted that it is important also to avoid bruising the muscular edges of the wound, and to prevent their being contaminated with purulent or other fluid if the operation includes the evacuation of such material. The beginner should remember that in most patients the abdominal muscles are thinner than text-books and anatomical plates would lead one to suppose.

There is no linea alba below the umbilicus, and it is scarcely possible, except in instances where the parietes have been much stretched, to avoid exposing one or both of the margins of the recti muscles. The precise construction of the rectus sheath, especially of that part that lies below the umbilicus, should be borne in mind. The pyramidalis muscle, when large, may entirely cover the median line, and section of the fleshy fibres cannot in such case be avoided. The muscle very seldom extends beyond the lower third of the interval between the pubes and the umbilicus.

The linea semilunaris may be represented by a slightly curved line drawn from about the tip of the ninth costal cartilage to the pubic spine. In the adult it would be placed about three inches from the navel. The outline of the rectus can be well seen when the muscle is in action. It presents three "lineæ transversæ," one usually opposite the xiphoid cartilage, one opposite the umbilicus, and a third between the two. The two upper of these lines are the best marked.

The linea semilunaris is now frequently used for opening the abdomen—*e.g.* in operation on the gall-bladder, on the vermiform appendix, or in abdominal nephrotomy. Care should be taken not to damage more than is absolutely necessary the nerves which supply the rectus and which enter its outer border (Fig. 32).

The site of the umbilicus varies with the obesity of the

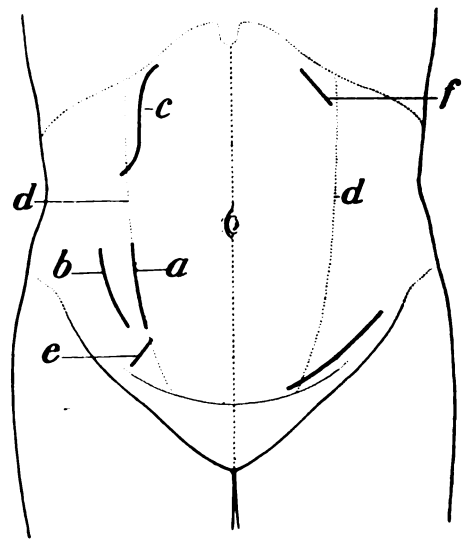

FIG. 32.—LINES OF INCISION FOR ABDOMINAL OPERATIONS.

a, for removal of vermiform appendix (through sheath of rectus muscle); *b*, ditto (outside rectus muscle); *c*, for operations on gall-bladder; *d*, linea semilunaris; *e*, line of deep epigastric artery; *f*, incision for gastrostomy. The line above Poupart's ligament on the left side marks the incision for radical cure of inguinal hernia.

individual and the laxity of the abdomen. It is normally situated from three-quarters of an inch to one inch above a line drawn between the highest points of the two iliac crests. The umbilicus is difficult to disinfect as regards its cutaneous furrows, and special care should be taken to effect this. Sometimes the umbilicus itself is excised, which makes accurate suturing easier. As a rule, a vertical incision in this region should be carried to one side of the umbilicus.

The only arteries of any magnitude in the abdominal walls are the two epigastric arteries, some branches of the deep circumflex iliac (especially its ascending division), the epigastric branch of the internal mammary, and the abdominal divisions

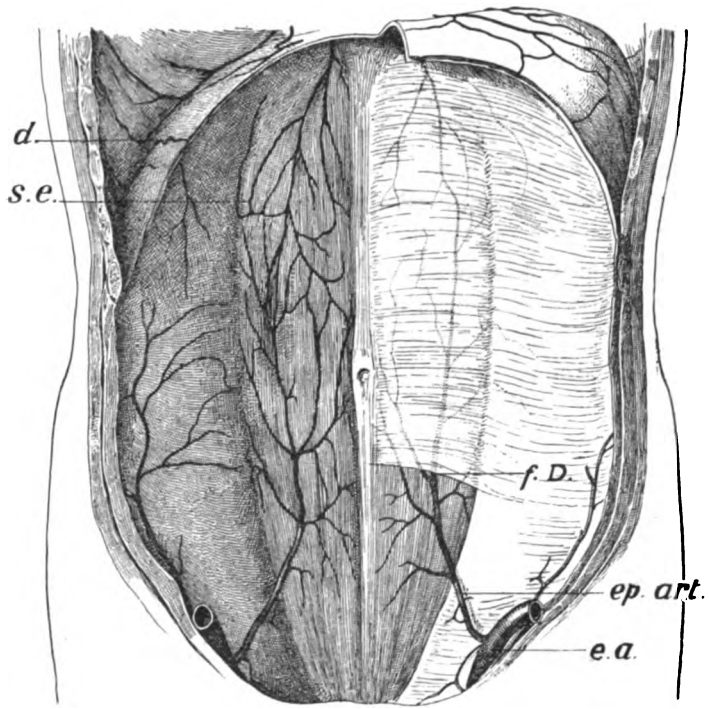

FIG. 33.—FRONT WALL OF ABDOMEN SEEN FROM BEHIND.
(*After Testut.*)

On the left side (of the drawing) the transversalis aponeurosis has been cleared away, on the right side it is left showing the fold of Douglas (*f.* D.); *e.a.*, external iliac artery; *ep. art.*, deep epigastric artery anastomising above with *s.e.* superior epigastric from internal mammary; *d*, diaphragm.

of the lumbar arteries. All these run in the deep muscular planes or in the subperitoneal tissue, and the surgeon should bear their position carefully in mind during certain operations. (*See* Fig. 33.)

1. The deep epigastric artery comes off from the external iliac midway between the anterior superior spine

and the symphysis. It runs in the subperitoneal tissue obliquely upwards for two inches to the outer border of the rectus, and enters the muscle on its posterior surface. It is of interest alike in connection with excision of the vermiform appendix, ligature of the external iliac artery, and radical cure of inguinal hernia. We have known of one case of the latter operation in which accidental division of the deep epigastric caused such alarming hæmorrhage as to necessitate ligature of the external iliac (the patient fortunately recovered). In another case, after excision of a vermiform appendix through the rectus sheath a large aneurysm formed on the deep epigastric artery in the subperitoneal layer.

2. The deep circumflex artery lies so close to Poupart's ligament and the iliac crest that it is never in the way of the surgeon, but behind the anterior superior spine it often sends upwards a large ascending branch, which runs between the transversalis and internal oblique. This may be divided in exposing the ureter, etc. (*see* Fig. 33).
3. One or more of the lumbar arteries, passing behind the quadratus lumborum and so forwards between the abdominal muscles, may be divided in the various operations on the kidney. In opening a psoas abscess from behind it is particularly important to avoid wounding a lumbar artery close to its origin from the aorta, as the hæmorrhage would be serious and difficult to control. To avoid them the knife is entered on the level of and close to one of the transverse processes, the arteries lying between them.
4. The superior epigastric, like the inferior or deep one, runs behind or in the substance of the rectus muscle. It may possibly be divided during an operation on the gall-bladder (right side) or during gastrostomy (left side).

5. The superficial epigastric and superficial external pudic vessels are of more interest to the surgeon than their size would indicate. During the radical cure of inguinal hernia and the high operation for varicocele one or other is always divided, and unless secured by ligature they may cause troublesome recurrent hæmorrhage. Of this we have known instances. Although all the superficial vessels are small, Verneuil has reported a case of fatal hæmorrhage from division of the superficial epigastric vessel.

Both the superficial and the deep epigastric arteries follow a line drawn from about the middle of Poupart's ligament to the umbilicus.

The following landmarks may here be noted. The aorta bifurcates about the level of the highest part of the iliac crest, at a point about three-quarters of an inch below and to the left of the navel. The cœliac axis comes off some four or five inches above the umbilicus. The superior mesenteric and suprarenal arteries are just below the axis. The renal vessels arise about half an inch below the superior mesenteric, opposite a spot some three and a half inches above the umbilicus, while the inferior mesenteric artery comes off from the aorta about one inch above the umbilicus.

It may be pointed out that in the female the respiration is more thoracic than abdominal. The converse holds good for the male, in whom the anterior abdominal parietes are consequently less steady. In the larger number, however, of cases for which abdominal section is performed the anterior belly wall is practically motionless at the time of operation.

Preparation of the Patient.—Very many directions—some of them not a little remarkable and ridiculous—have been given under this head. The subject of abdominal section needs but the preparation that should precede any great surgical operation. (*See* pages 24-28.) There is very little that is especial to note. If the patient be a female, the operation may be conveniently performed shortly after the complete

cessation of a menstrual period. It is important in every case that the condition of the kidneys should be investigated, and before operations on the kidney or bladder it is well that for a week before the operation the urine should be examined every day, and a note made of the precise amount passed in the twenty-four hours.

An aperient should be given over night, and be followed by an enema early on the morning of the operation. When convenient and possible, the patient should have a hot bath on the evening that precedes the operation. The whole area of skin which will be exposed during the operation, that which will not be protected by sterilised towels, should be shaved, cleansed with ether and an antiseptic in alcohol, and then compressed (*see* pages 25, 26).

In preparing this " field of operation " it is well to go beyond the minimum required. Especially before operations on the kidney, the whole circumference of the abdomen should be prepared. But to insist on shaving and preparing the skin of every abdominal patient from the nipples to the knees, as is done by some surgeons, is a good instance of excess of zeal with deficiency of common sense.

The details of the patient's dress have been already dealt with (page 27), as well as the preparation of the room in which the operation is to be performed (page 37).

Instruments Required.—Three scalpels of different sizes. Dissecting forceps (2 pairs), and fine forceps with serrated points. Straight probe-pointed bistoury. Pressure forceps (10 or more pairs). Large pressure forceps (2 or 3 pairs). Medium-sized pressure forceps. Needle-holders. Small needles (curved and straight). Two large blunt hooks. Scissors (straight and curved on the flat). Catgut, kangaroo tendon, or silk in various sizes. Silkworm gut. Sponges. Sponge-holders.

To these may be added—dishes for instruments, mackintosh sheets, the dressings and binder, an electric lamp or an ordinary lamp, and hand mirror.

The pressure forceps.—The small pressure forceps are of the ordinary pattern (Fig. 8, page 47). The large pressure forceps—designed by Sir Spencer Wells—are constructed upon the same lines, but are of much larger size. They measure about ten inches in length, the blades occupying about two and a half inches. Some are straight; others have the blades bent at an angle to the shanks (Fig. 34).

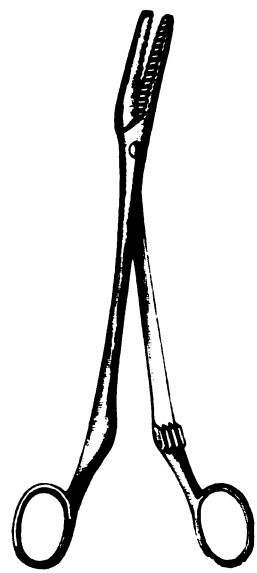

FIG. 34.—SPENCER WELLS' LARGE COMPRESSION FORCEPS (CURVED BLADES).

They are extremely useful for seizing and holding a tumour or cyst wall, for grasping an extensive mass of adhesions, or for clamping omentum. They form, moreover, safe and convenient sponge-holders (page 106). Medium-sized pressure forceps, with blades about one inch and a half in length, are occasionally useful.

The blunt hooks are used for the purpose of steadying the edges of the abdominal wound while the sutures are being applied (page 48).

The hook should be as thick as a No. 6 catheter, should have a perfectly blunt point, and should form the curve of half a circle with a diameter of not less than one inch. The hook and its handle are made of one piece of metal.

Drainage tubes are now very seldom required in abdominal surgery. When a purulent collection is opened up, the ordinary rubber drainage tubes, supplemented or not by drains made of gauze, are the most useful. In non-suppurative cases drainage when required—and it is very rarely needed—is best carried out by means of lengths of sterilised gauze.

The best *sponges* for abdominal operations have been already described on page 60. Three or four of these sponges will suffice for a simple abdominal section such as an exploratory incision or the removal of a non-adherent vermiform appendix. These

special sponges are " quilted " so that no particle can be accidentally left behind, and to each one a long thread or tape is attached, the end of which remains outside the wound. If these sponges are formally counted before and after the operation, and if under no circumstances are any other sponges introduced into the abdomen, the risk of leaving a sponge behind is reduced to a minimum. Should ordinary sponges be employed, they should be selected with care. Supposing that twenty are employed, ten should be ordinary rounded sponges of medium size. Six should be small sponges, to be used with the sponge-holders, and the remaining four should be flat, two of them large and two small. All should be of the finest Turkey sponge, and it is desirable that the flat sponges should be of very close texture.

Sponge forceps made upon the type of the largest pressure forceps, but much lighter, form the best sponge-holders for abdominal operations. They hold the sponge evenly and very firmly, and enable the surgeon to retain perfect control over it when it is traversing the depths of the peritoneal cavity.

Antiseptic solutions, etc.—The instruments, after removal from the steriliser, should be placed in sterilised water at the temperature of 100° F. Many operators prefer to have the instruments dry, and placed on a sterilised cloth or towel. If ordinary sponges be used, they should be rinsed in warm sterilised water which is frequently changed. Should the abdominal cavity or any part of it need to be washed out, sterilised water at the temperature of 100° F. is employed.

Position of the Patient.—The operating table should be of the usual height, and should be narrow. The patient should lie as near as possible to the right-hand side of it. The patient's upper extremity should be supported, clear of the edge of the table, and with the elbow flexed. Straps buckled round each wrist and passing behind the head are convenient for this purpose, but on no account should the patient's arms be kept tightly drawn backwards. Temporary loss of power

in the limb is apt to follow the placing of the hand behind the head or behind the back. In some cases this paresis has lasted for months. The lower extremities are neatly enveloped in a small blanket, and around that a thin mackintosh is tightly wrapped with equal care. No blanket is left exposed, and the mackintosh reaches well up the thighs. Its object is to keep the blanket dry. The flannel jacket worn by the patient covers the chest and upper limbs. Towels, taken direct from the steriliser and absolutely dry, should be arranged around the area of operation on all sides.

Shaving all the hairy surface of the abdomen will as a rule have been carried out before the operation as a preliminary to disinfection of the skin.

The sterile towels are so applied over the trunk and lower limbs that only the area of the operation is exposed. No blanket is visible.

The surgeon's hands can only come in contact with the sterile towels; and should any instrument be laid down for a moment near to the wound, it will rest upon the same aseptic surface. Before the towels are finally settled in place, a small bath towel or a large pad of cotton wool should be forced in between the legs and wedged up against the perineum. This will serve to collect any fluid which may find its way under the protecting sheet, and save the delay of much cleaning after the operation has been completed.

The table should be so placed that its foot is in front of a window. The chloroformist stands at the head, the surgeon on the right-hand side, and the assistant on the left. A table for the basins, antiseptic solutions, etc., is placed to the left of the operating table, and here the two nurses are placed. A smaller table for the instruments stands close to the surgeon's right hand. Upon this table may also be kept a small bowl of warm sterile water, in which the surgeon can rinse his hand to remove blood-clot, etc., from time to time during the operation.

Two nurses are required. Only one assistant is necessary

for most operations. His duty is to sponge, to look after the forceps, to prevent intestine from protruding, to steady the wound edges while the stitches are being introduced, and to help in any other way.

THE OPERATION

1. The Parietal Incision.—The surgeon steadies the abdomen with the left hand, the thumb being on one side of the intended wound and the fingers on the other, and makes a clean cut in the median line from two to three inches in length.

The incision is usually placed midway between the umbilicus and the pubes, and stops some two inches above the pubes. In fat subjects the incision will have to be a little longer. The knife should make a clean cut through the skin and subcutaneous tissues down to the aponeurosis. Bleeding is checked by pressure forceps, which are left *in situ*. The bleeding vessels must be neatly isolated and neatly picked up. A casual mass of subcutaneous fat must not be clutched up with the vessel between the blades of the forceps. The operator need not trouble about the sheath of the rectus. There is no linea alba below the umbilicus, and the knife need only follow the median line, avoiding the cutting of muscle as far as possible. Unless the two recti are separated by distension one or both of the rectus sheaths will as a rule be opened.

The transversalis fascia is now reached. It is possible to mistake it for the peritoneum, and the subperitoneal fat beyond for omentum. This fascia and the fat, if any, beneath should be divided by a clean cut of the knife. No director is required, nor should one be used. It is about this stage of the operation that some surgeons enlarge the area of the wound with the fingers, tearing up the fascia in a meaningless manner. All such handling of the wound is useless, and distinctly to be avoided. The advice that the peritoneum should be exposed by tearing is not sound.

It is important clearly to recognise the peritoneum. It is best identified by noting the tissues that have been cut through.

The " blue colour," the " glistening surface," and the " arborescent vessels " belong to the department of fiction.

When adhesions exist, the peritoneum may not be demonstrable as coherent membrane.

Before any attempt is made to open the abdominal cavity all bleeding should have been checked. Any pressure forceps that are attached need not be removed at the present stage. The peritoneum should be pinched up as a very minute fold with a good pair of dissecting forceps. Normal peritoneum can be so picked up. Thickened and adherent peritoneum cannot be thus dealt with, nor can the wall of the bowel be quite so readily and minutely picked up should a piece of gut be exposed and its surface be mistaken for the lining membrane. The forceps that grasp the little folds of peritoneum should be moved to and fro and lifted up and down, to ascertain whether the membrane is free or not. The membrane is finally divided by cutting upon or close to the point of the forceps, while they are being drawn away or lifted up. No hook or other unusual instrument is required to pick up the peritoneum, but toothed forceps are often useful.

When adhesions exist, there is difficulty in ascertaining when the abdominal cavity has been really reached, and there is nothing to guide the operator but his surgical and anatomical intelligence. Any doubtful layer of tissue should be picked up and gently rolled between the finger and thumb. Its character can in this way be at once estimated, and the existence of deeper attachments demonstrated. The operator who has the fear of adhesions before his eyes, and who has not noted the layers of tissues as they have been cut, may readily separate and strip off the undivided peritoneum with his fingers, under the impression that he is dealing with adhesions within the abdominal cavity. This is especially apt to occur when a large smooth tumour is pressed against the parietes.

The peritoneum should be divided by a clean even cut. It may conveniently be divided by scissors if preferred.

As soon as the abdomen is opened, the divided peritoneum

on either side of the centre of the wound is seized with pressure forceps. These forceps remain in place until the operation is completed. They act as retractors; they keep the peritoneum in position, and they render the introduction of the finger or of a sponge very easy. They also serve as a guide to the introduction of the sutures. Before they are dispensed with the little margin of peritoneum which they have hold of should be cut away with the forceps, since this tissue is likely to be damaged by long compression. When the forceps are in position, two fingers can be introduced for purposes of exploration.

In an abdominal section of ordinary length two pairs of Wells' forceps hold the peritoneal edge towards either end on one side of the wound, and two on the other.

The peritoneum has a remarkable way of slipping out of reach under the muscles unless forceps are used to retain it. Special and elaborate elbowed instruments with prongs have been invented for the same purpose, but they are far inferior to the simple Wells forceps.

If the incision has to be enlarged, it is effected with a straight probe-pointed bistoury, the two fingers being used as a grooved director. If the wound be extended downwards, the position of the bladder must be defined before the knife is used.

If the hand has to be introduced, the incision must of necessity be increased. There is often a disposition not to make the wound large enough. More harm may be done by rough efforts to drag a solid growth through a small incision than by a liberal extension of the incision in the median line.

In certain cases, as soon as the wound has been completed, a large "sponge" may be at once introduced into the pelvis. It is retained there during the operation, and by absorbing any blood that finds its way into Douglas's pouch saves sponging at a later stage. The intestines must be prevented from protruding either by the introduction of a flat artificial sponge or by the fingers of an assistant. One of those present should be entrusted with the responsibility of taking count of all sponges introduced into the abdomen.

It has been claimed that in ovariotomy, and other forms of abdominal section in which the surgeon works chiefly in the lower part of the abdomen, there is a decided advantage in placing the patient in Trendelenburg's position—*i.e.* with the pelvis raised and the abdomen sloping downwards toward the thorax. It is urged that by this means not only are the intestines kept out of the way, but the tendency to venous congestion is diminished and hæmorrhage is more easily controlled. The Trendelenburg position is almost essential during hysterectomy, but there is a tendency to employ it in many other operations where it is quite unnecessary. We very rarely use it on account of the obvious drawbacks inherent in it. The viscera being forced up towards the diaphragm the patient's respiration is impeded, and the anæsthetist thereby embarrassed. If the operator employs it he should see that the natural position is restored as soon as possible. Some Continental surgeons go so far as to advocate the Trendelenburg position in all appendix operations, which is absurd.

The omentum often gives much trouble, especially the fine, thin omentum of young children, by clinging to the fingers and to sponges, and by becoming entangled in instruments. It may be necessary to keep it out of the way by means of a long narrow sponge attached to slender forceps.

2. Exploration of the Abdominal Cavity.—As soon as the incision allows of the operator's hand being introduced he should, as a rule, make a general examination of the accessible viscera. For example, in a case of gall-stones the surgeon ascertains whether they are confined to the gall-bladder or if they are also present in the common duct. The condition of the pancreas is often a matter of importance to determine in disease of the upper part of the abdomen.

Before abdominal nephrectomy is commenced the condition of the other kidney should have been made out. During abdominal section for cancer of the stomach, intestine, etc., the liver should be carefully examined. It has often happened that two or more distinct diseases have been found to exist within

the abdomen. Thus we have more than once, when operating for cancer of the transverse colon, discovered large calculi in the gall-bladder. A floating kidney on the right side may complicate disease of the gall-bladder, disease of the ovary or Fallopian tube may exist with an inflamed vermiform appendix. We have known colotomy for cancer of the sigmoid fail to give relief owing to the small intestine being obstructed by a band. In one remarkable case we found the vermiform appendix tied down by old adhesions, the gall-bladder packed with stones, and general tubercular peritonitis.

In fact the conditions met with in exploratory laparotomy are often complex and unexpected, rarely agreeing exactly with the diagnosis made before operation. Hence the necessity for a careful examination with the hand as soon as the abdomen is opened.

3. Treatment of Adhesions.—Adhesions must be dealt with according to common surgical principles. The lighter, more recent, and more slender ones can be broken down by the finger or by a sponge.

The firmer ones must be clamped, divided, and tied—either with catgut or fine silk. Extensive strands of adhesions should be clamped in sections, cut, and the bleeding points picked up individually with artery forceps, and tied in the usual way.

In no circumstances is the use of the actual cautery to be commended for the arrest of bleeding from divided adhesions.

Oozing from a level surface can very usually be checked by continued pressure with a sponge. If the oozing be more persistent, and if no individual vessels can be isolated and tied, the bleeding surface when small may often be "sequestrated" or sewn over. A Lembert's suture is made to traverse the peritoneum on either side of the bleeding area, and when the suture is drawn tight the bleeding surface is covered over. When the area is large a fine needle, carrying silk, is made to pass beneath the bleeding surface, and when this buried suture is drawn tight the surface is constricted and turned in. This may be called "sewing in" as compared with "sewing over," when

peritoneum is concerned. Great care should be taken in dealing with deep pelvic adhesions. They can be exposed by the use of ivory spatulæ, and in demonstrating their character and attachments the electric head lamp is very useful, or, if this is not available, reflected light from a mirror.

Adhesions to the bowel and to the bladder must be gently dealt with. When slender, they can be readily stripped off by means of a sponge. When dense and extensive, it is better to clamp the adhesion, to cut it through at some little distance from the viscus, and to ligature it *in situ*. In separating adhesions from bowel, it is easy to tear away the serous coat and to expose or even tear the muscular coat. Such false membranes are probably nourished from the viscus to which they are attached, and we have seen no harm to follow from leaving quite considerable masses of such tissue attached to intestine. In cases where a portion of cyst wall is firmly attached to the bowel, it is very undesirable to make persistent attempts to separate the two. It is far better to cut away the cyst, leaving the adherent portion still attached to the bowel. Such attached portion may be reduced to the smallest dimensions, by dissecting off as many laminæ as possible, and be allowed to remain as a permanent appendage to the gut. In a few cases we have left a considerable portion of the cyst wall still attached to the bowel.

It should be borne in mind that, in endeavouring to free the intestine of firm adhesions, it is very much more easy to tear the bowel than to tear the false membrane.

Moreover, such attempted separations, even when they do not tear the gut, are apt to strip off a great deal of its peritoneal coat. The muscular coat beneath is probably atrophied from disuse, the result of the adhesion, and a perforation of such damaged intestine is quite possible. Extensively adherent intestine will be found to have very attenuated walls, and to be most readily torn.

Adherent omentum can be dealt with in considerable sections. The adhesions may be peeled off with the finger.

Portions, of the thickness of the fore-finger, may be included in one ligature. It is more satisfactory, however, in dealing with omentum, to ligature the individual vessels with catgut or fine silk whenever practicable. The method adopted must depend upon the vascularity of the tissue. In some cases, where much traction has been exercised upon the epiploon, its cut surface will scarcely bleed at all. On the other hand, when an ovarian cyst, with a twisted pedicle, is obtaining its chief or sole blood supply from omental adhesions, the vascularity of the tissue is often considerable.

Adhesions may in some cases be so dense, so close, and so extensive that they have to be divided by the scalpel by extensive incisions. It must be borne in mind, however, that such adhesions have sometimes but a slight vascularity, and that they can be often divided without remarkable bleeding. Indeed, we have observed that the hæmorrhage from a surface exposed by such division is usually not so considerable as that from the area exposed by tearing down soft recent adhesions with the finger. Still, these dense attachments must always be regarded with the greatest respect.

In many instances when an organ, such as a cyst or a diseased vermiform appendix, is so very adherent as to be described as buried or lost in adhesions, it is well to ignore at first the actual adhesions and to divide the peritoneum at some little distance from the adherent organ, so as to open the subserous tissue. The finger is introduced into this lax tissue, and the separation of the organ is carried out subperitoneally, the adhesions being divided upon the finger (introduced beneath them) as soon as they are well isolated.

Whenever practicable, it is desirable that a very adherent structure should be first of all approached by the subperitoneal route. When no inflammatory adhesions exist, but the tumour or cyst has, in enlarging, made its way beneath the peritoneum so as to become more or less entirely hidden, then the separation of the mass should always be effected by dividing the peritoneum around it, and by enucleating it through the

medium of the subperitoneal tissue. In such a proceeding care must be taken to note the position of the normal blood-vessels of the part concerned. These are secured as they are met with.

4. Toilet of the Peritoneum in Septic Cases.—The thorough cleansing of the peritoneal cavity, well termed by Worms "*la toilette du péritoine*," is a matter of primary importance in certain abdominal sections.

In an abdominal operation in which no septic material is encountered—and the majority of abdominal sections are of this type—the peritoneum needs very little if any attention, The serous membrane is very well able to look after itself, and the more one sees of abdominal operations, the more one is impressed with the marvellous powers of the peritoneum in this direction.

Its power of protecting itself, of dealing with sterile effusions (such as blood or the fluid of some cysts), and of rapid healing, is only weakened and damaged by surgical interference. Extensive sponging out of the peritoneal cavity in non-septic cases is to be condemned, and flushing out of that cavity in such cases is absolutely unwarranted.

It is well that any effusion, such as blood or cyst-fluid, should be removed, but that object is never to be persisted in at the cost of extensive sponging. In connection with non-septic cases, the term "the toilet of the peritoneum" has done harm, as it has led to a perfectly unnecessary damage being inflicted upon a delicate membrane which is well able to look after itself so long as it is uninjured. After any aseptic abdominal operation, all blood-clot and cyst-fluid should be removed as far as is possible and as completely as is possible, but never at the cost of long-continued and over-elaborate sponging. It is a mistake to suppose that pure blood in a non-septic abdominal cavity is a noxious thing. It is quite harmless in comparison with the over-fussy sponge.

In the cases to be considered in the present section, not only has much blood found its way into the pelvis and among

the intestines, but a collection of pus has possibly discharged itself during the operation, or fæcal matter has escaped through a perforation of the bowel, or the abdominal cavity has been flooded with the fluid from a septic cyst. In such instances no trouble must be spared until the peritoneum has been cleansed of the impurity.

As to the actual process. The sponge which was probably placed in the depths of the pelvis at the commencement of the operation should be removed, and then all the soiled districts of the peritoneum are very gently cleansed by sponges on holders or held in the hand. Such sponges will absorb the grosser part of the effusion.

It is especially, of course, in Douglas's pouch that fluid is apt to collect. Another district is the iliac fossa, and another part that particularly encourages the accumulation of fluid is the perirenal region. In extensive operations, where a large parietal wound has been made, these districts may be sponged out with comparative ease.

Experience has shown that indiscriminate irrigation of the abdominal cavity does more harm than good, and that "evisceration" and rough handling of the damaged intestines is dangerous. The primary focus of suppuration must be dealt with and its area drained, further drains may be required in Douglas's pouch, or the iliac fossæ, but drainage should be limited as a rule to the lower abdominal area and the pelvis. The position of the patient both during and after the operation should be that which favours dependent drainage; in other words the trunk must be raised. This position is maintained by pillows, and it is sometimes referred to as the Fowler position. During the next few days the more the patient can be raised towards the sitting posture the better.

The modern treatment of septic peritonitis has been so admirably stated by Mr. C. J. Bond (*Brit. Med. Journ.*, Dec. 15th, 1906) that the following quotation is given entire:—

"As a general rule, in the large class of cases of diffused septic peritonitis which depend on infection from some portion of the

intestinal tract and are associated with the *Bacillus coli*, either alone or in combination with staphylococci, the surgeon should regard the upper or diaphragmatic area of the peritoneal cavity, unless itself the seat of primary infection, as sacred, and leave it severely alone.

"Any violent or free irrigation of this area will wash away the serous exudates containing the active phagocytes, possibly also the stimulating, helpful *Staphylococcus albus*.

"Moreover, any exploration of this upper dome, if necessary to settle the question of local infection here, must be undertaken as a distinct operation with fresh instruments, in order to avoid reinfection with more virulent germs.

"In the next place, since the great majority of cases of septic peritonitis begin at one focus or primary seat of infection, the guiding surgical axiom is that the first object of operation must be to attack this primary focus.

"Thus, all local abscesses must be drained. The perforated or gangrenous appendix must be removed or isolated, and the virulent purulent exudate in its immediate neighbourhood sponged away, and the potential cavity tamponed or drained.

"The perforated bowel must be sutured, the necrotic area of intestine sequestered, or the gangrenous portion of bowel removed. In like manner, the perforated gall-bladder or the ruptured pyosalpinx or suppurating ovarian cyst must be the primary object of attack.

"Where the peritonitis is due to obstruction from distended coils, which, unless emptied, are hopelessly paretic, the question of enterotomy and siphonage must be anxiously considered. It is, however, certain that the opening of bowel so distended introduces a serious risk of further infection by organisms of exalted virulence.

"Having thus dealt with the primary seat of invasion, the very important question arises as to our proper attitude to the general cavity with its diffused infection, sticky coils, and thin, turbid exudate.

"There is little doubt that in the majority of cases of

moderately virulent infection, such, for instance, as those arising in connection with a gangrenous or perforated appendix, the cost of interference with the general cavity is too great. Evisceration is fatal; while free and forcible irrigation is apt not only to wash away the defending phagocytes, but also to spread the virulent organisms from the primary focus over the whole area of membrane, already taxed to the uttermost to repel the invasion.

"As a general rule, we shall find that our safety lies in making things secure locally, by the removal of the primary focus, combined with dry sponging or strictly local and open irrigation and local drainage. While if considerable collections of fluid exudate exist in the pelvis or loins, then it is better to drain these areas, especially the pelvis, suprapubically with large rubber drains or rubber tubing combined with gauze wicks.

"Such is the treatment of the large number of cases of diffuse peritonitis of moderate severity. There are, however, other groups of cases, violently virulent on the one hand and mild on the other, which call for special remark.

"First, the infections due to the most fatal *Streptococcus pyogenes*, or the less common but almost as fatal *Bacillus pyocyaneus*. These organisms are introduced from outside, as in cases of puerperal peritonitis. Here the infection is diffuse and virulent from the outset; there is little or no chance of dealing with any primary focus, and phagocytosis is feeble or absent.

"It is, perhaps, in these most fatal cases that the freest irrigation, with drainage of the pelvic and lumbar areas, is really called for.

"Even in these extreme cases I would avoid, if possible, interference with the diaphragmatic area. One has repeatedly seen a patient going fairly well through an abdominal section for general peritonitis, preserving a good colour and fair pulse, when for some reason or other interference or irrigation takes place in this sensitive area—a rapid change for the worse at once takes place, the aspect, colour, respiration, pulse, and blood

pressure all alter, and the patient never returns to his former point of vitality again.

"Then there are the cases of much milder degrees of virulence—those due to intraperitoneal hæmorrhage. These may be safely and advantageously treated with free irrigation after the primary bleeding focus has been dealt with; not only so, but large quantities of normal saline fluid may be left in the peritoneal cavity, and drainage is not, as a rule, necessary.

"The same treatment applies to cases of perforated gastric and duodenal ulcer, in which, though the urgency for immediate operation is extreme, yet the virulence of the infection is not of a very high degree, and consequently the efficient treatment of the perforation, together with removal of all foreign material by free irrigation, may render drainage unnecessary, or it may be limited to the pelvic basin if that contains much turbid exudate.

"Cases of gonococcic infection due to extension from infected Fallopian tubes, or the rupture of a pyosalpinx, may be treated in the same way, though in these cases the pelvis should be drained.

"Cases of pneumococcic peritonitis also require irrigation and drainage.

"*Peritonitis from perforation in typhoid fever.*—The efficient closure or sequestration of the perforation is essential in these cases, and Haller and Ashhurst have shown that the actual virulence of the infection, unless accompanied by streptococci, is not very great. The seriousness of the position lies in the patient's exhausted state, and in the delay which so frequently occurs before the operation takes place; hence the extreme importance of an early recognition of the cardinal symptoms pointing to perforation, while local irrigation and drainage will in a certain number of cases—some 20 per cent.—limit the spread of infection and save the patient.

"Thus we reach certain general conclusions about treatment.

"First, the absolute necessity of preventing further infection from the primary virulent focus by appropriate treatment at

this spot, together with the removal of the local purulent exudate and extravasated foreign material.

"Secondly, the lower the degree of virulence of the infecting organism or organisms the greater the safety and benefit of general irrigation, provided due regard be paid to the sensitiveness of the diaphragmatic area; while in the infection of greater virulence, such as the *Bacillus coli* in cases of appendicitis and intestinal necrosis, irrigation of the general cavity is distinctly harmful in removing protecting phagocytes and spreading infection.

In the case of the severest type of infection—streptococcal—our only hope, in the absence of an efficient antitoxic serum, lies in very free irrigation, though most of these cases are hopeless from the first.

"In fact, I would sum up the question of irrigation with this statement:

"It is beneficial where the peritoneal cavity contains foreign material, such as blood, gastric or duodenal contents, or fæcal matter, infected bile or urine, capable of removal by flushing. It is also useful locally for the removal of purulent material at the primary focus of invasion, in which case the phagocytes are no longer living and active. It is harmful in the case of fibrinous deposit and sticky coils without fluid, and must be used with the greatest reserve, if at all, in the case of sero-purulent exudates containing active phagocytes."

5. Counting of Instruments.—On completing the intra-abdominal operation, great care should be taken to ensure that no sponge or gauze-pad or instrument has been left in the depths of the cavity. The sponges, pads, and clamp forceps should be formally counted. The leaving of a sponge or instrument within the peritoneal cavity is a catastrophe which no surgeon would feel greatly disposed to make public, and yet Dr. Wilson (*Trans. of Amer. Gynæc. Soc.*, vol. ix.) has collected no less than twenty-one instances of this unfortunate accident.

We have known of a case in which the overlooking of a sponge during the performance of hysterectomy led to subsequent

abscess and fæcal fistula, which latter persisted for many months after the sponge had been removed. Dr. Fergusson Stewart, of West Australia, removed by operation a forceps from the intestine which had remained in the abdomen for ten years after an ovariotomy (performed by another surgeon). In this

FIG. 35.—PAIR OF WELLS' FORCEPS WHICH HAD REMAINED IN A PATIENT'S ABDOMEN TEN AND A-HALF YEARS AFTER OPERATION (exact size).

remarkable case (Fig. 35) the forceps had caused short-circuiting of intestine owing to the bowel being nipped between the handles.

6. Closure of the Abdominal Wound.—In sewing up the incision made through the abdominal wall, the surgeon should aim at leaving the parts so far as possible in their original condition, *i.e.* the peritoneal surface should be smooth, and the scar in the muscular and aponeurotic layers firm and unyielding. Thus the possible dangers of adhesions of intestine, omentum, etc., and of ventral hernia will be avoided. Further, if any buried sutures are employed they must be absolutely aseptic; otherwise they are apt to cause troublesome sinuses, which will only heal on the expulsion of the sutures.

In many parts of the abdomen, such as the linea alba, a good plan is to pass silkworm gut stitches through skin, aponeuroses, muscle, and peritoneum. These sutures are securely knotted, and should be left in a full fortnight. A more perfect peritoneal surface can, however, be obtained by first suturing the two cut edges of this layer (these edges are secured by the

pressure forceps which were applied when the wound was made). A continuous and fine catgut stitch, introduced on a curved needle, is the most convenient, the line of suture being finished off as shown in Fig. 71, p. 249. This detail, which takes only a minute or two, is strongly recommended in the majority of cases; besides preventing adhesions of intestine, etc., in the future, it is a convenience during the rest of the suturing, as the peritoneal cavity is thus shut off. A series of silkworm-gut sutures is then passed through the remaining layers.

Some surgeons bury silkworm gut in the muscular planes. In America, as we have seen, silver wire has been freely employed for buried sutures. The latter, we must repeat, is a dangerous material, as its rigidity causes pain when the patient gets about, and it has had to be removed in a great many cases. Silkworm gut is safer, and will not be absorbed, but the sharp ends are a drawback.

Kangaroo tendon, in our opinion, is far preferable to either.

When cutting through muscular planes, as in the usual incision for removing the appendix, it is unnecessary to make a wide transverse gap in either internal oblique or transversalis. It is even possible (by dissociating the muscle fibres) to avoid cutting any of them across; this, however, is carrying caution to extremes. Provided that the parts are not in a septic condition, a few sutures of kangaroo tendon should be employed to each layer in turn, the incision in the peritoneum having been first sewn up by the continuous catgut suture.

If the abdominal incision be extensive, a thin flat sponge of greater length than the parietal wound is placed upon the intestines under the opening. It is retained during the introduction of the sutures. It serves to protect the intestines, and to absorb such blood as oozes from the suture points before the sutures are tied. If the thread be too small and the parietes thick, the suture has a tendency to cut through the tissues. If it be too large, it acts as a species of seton. Large-sized threads of silkworm gut appear to be peculiarly well adapted for these wounds. They merely require care in tying (page 113).

and a certain number should be tied in a double knot, so as to avoid the risk of giving way when the patient strains or vomits.

Many different kinds of needle are used for passing the sutures, straight and curved, mounted needles with eyes at the points, etc.

The last-named we have found clumsy and not to be recommended. There is less risk of wounding intestine or of pricking the operator's finger with curved than with straight needles, and it is much easier with curved ones to take up just the layers required in the needle.

The following description applies if the surgeon chooses the method of passing silkworm-gut sutures through all the layers.

A blunt hook is inserted into either extremity or angle of the incision, and by exercising traction upon the hooks in opposite directions (precisely in the median line) the edges of the wound are rendered straight and parallel to one another. The incision opening can be made, in fact, a mere chink. By the use of the hooks the most perfect adaptation of the edges of the wound is ensured (Fig. 29, page 71). If the abdomen be distended, the narrowing of the incision opening tends to prevent protrusion of the intestines. If the belly wall be flaccid, the hooks enable the assistant to make the skin tense, and at the same time to draw away from the viscera the part of the parietes about to be sutured, and thus render a wound of the latter less easy.

The sutures should be introduced close to the margin of the wound, and at intervals of half to three-quarters of an inch from one another.

No suture should be tied until all the threads have been introduced, and until it is seen by traction upon the threads that a perfect adjustment of the edges can be effected.

The sutures should be tied in order from above downwards, traction being maintained all the while upon the blunt hooks. Care should be taken that the suture, as it is being tied, does not pick up and include a shred of the omentum. The peritoneal surface of the wound should be carefully examined with

the finger from time to time. Before the last two, or possibly three, sutures are tied, the flat sponge should be seized with a pair of large pressure forceps and carefully dragged out, the blunt hooks being relaxed the while. Omentum is more apt to be included in the last sutures tied than in any others. The hooks are not removed until all the deep sutures have been secured.

Superficial sutures may now be introduced at any spot along the wound where the skin still gapes between the deep suture points.

ACCIDENTS DURING THE OPERATION

The special accidents which may occur during the operation almost entirely concern wounds and other injuries of viscera. Such accidents are scarcely possible in a simple laparotomy, and could only result from inexcusable carelessness.

Accidents connected with the Parietal Wound.—In not a few exceptional instances the intestine, and even the bladder, have been incised in making the parietal wound. The bowel may have become adherent to the parietal peritoneum, or be very closely pressed against it in cases where it is distended. Moreover, when enormous coils of dilated bowel are lying tightly wedged against the anterior parietes, it may be difficult to tell when the peritoneal cavity has been opened. In such a case the thinned bluish-coloured wall of a coil of distended bowel may be mistaken for the parietal peritoneum, and may be picked up with forceps and incised. This is a more excusable accident when the serous coat of the bowel has been dulled by commencing peritonitis.

When extensive and complicated adhesions exist between the intestines, and possibly also between them and the parietal peritoneum—as in some instances of chronic peritonitis—it is very easy to wound the bowel in attempting to demonstrate the peritoneal cavity.

The bladder has been wounded in making the parietal wound, even when the viscus had been carefully emptied by catheter

before the operation. In such circumstances it has usually been found that adhesions have prevented it from contracting and from sinking into the pelvis. In all cases extreme care should be exercised, when, for any reason, the incision in the abdominal parietes has been continued lower down towards the pubes than usual.

Sir Spencer Wells records a case in which he cut into a patent urachus, from which urine escaped. He closed the opening by one of the sutures used to close the incision in the abdominal wall, and no inconvenience followed.

Accidents connected with the Intra-abdominal Operation.—These include the accidental wounding of viscera with the knife or scissors, but the great majority occur in connection with the treatment of adhesions. It is in attempting to remove ovarian tumours embedded in extensive adhesions that the most numerous accidents have occurred. The anatomical outline and the aspect of a part may be greatly altered by serous adhesions, and a viscus so disguised may be wounded in dealing with the false membranes that cover it.

In attempting to break down adhesions, the intestine has been torn, and the same accident has happened to the bladder.

The rectum has been lacerated or divided during the separation of adhesions. The ureters have been cut accidentally, and have been included in ligatures attached to deep adhesions. "It is remarkable," writes Sir Spencer Wells, "that in cases of adhesions low down in the pelvis the ureters should escape injury so often as they do. I suspect that their condition has been overlooked in some post-mortem examinations, and it is probable that in some of the cases where suppression of urine has been a prominent symptom, one or both ureters may have been injured."

Treatment of Injuries to the Hollow Viscera.—Wounds of the intestine should be carefully cleaned, and at once closed by the Lembert or Czerny-Lembert suture, fine silk being used.

During the remainder of the operation care should be taken to protect the coil so treated from pressure or further injury.

In cases of more extensive damage—as where a portion of the gut has been torn away—the bowel should be resected, and the divided ends at once united by suture. Should this accident occur during an operation that has been already of unusual duration, and should it seem unsafe further to prolong the operation in order to unite the bowel, the two ends of the intestine may be brought out together at the parietal wound and an artificial anus established. This can be closed by a subsequent resection procedure.

Wounds of the bladder must be adjusted by sutures in a double row—the first involving the mucous membrane only, the second the outer coats. After the operation a syphon catheter should be introduced, so that the bladder may be kept perfectly empty for four or five days. Twice a day the bladder should be gently washed out with a weak boric acid lotion.

Laceration of the gall-bladder could not be safely treated by suture only. Either a biliary fistula should be established, or the entire gall-bladder should be removed.

If one ureter has been accidentally divided, a careful attempt should be made to unite the two ends by suturing, to facilitate which the lower end should be split. Drainage in the loin should be provided. Suturing has been carried out with success in several cases. If it be impossible, two courses are open: first to ligature the ends (after which the kidney will atrophy); or, secondly, to bring the proximal end out in the loin, and so establish a urinary fistula. The latter course will render subsequent nephrectomy necessary.

Treatment of Injuries to the Solid Viscera.—The liver is the only solid organ that appears to have been injured during ovariotomy. Bleeding from a wound or laceration may be arrested by pressure with a sponge; and if that fails, by the application of sutures passed into the substance of the organ.

Lacerations of the spleen or of the kidney may be closed by catgut sutures, followed by the uniting of the peritoneum over them.

DRESSING OF THE WOUND

This will depend, of course, upon the individual practice of the operator. Every possible form of dressing has been employed. There is probably no better dressing than a light one of sterilised plain or bicyanide gauze. The layers of gauze to be applied next the wound are wrung out of warm water, as they then adhere better. Over the gauze an even layer of sterilised wool is placed.

That portion of the binder which should come in contact with the patient's back may be lined with lint, carefully sewn on.

The binder is tightly and evenly applied, and secured by safety-pins.

The weak part of all dressings applied to laparotomy wounds is the lowest part. It is here that the dressing or bandage "rucks up," and it is easy in this direction for the wound to become infected. To obviate this defect two narrow strips of flannel bandage are so applied around the thigh as to keep the binder in place and also in close contact with the skin.

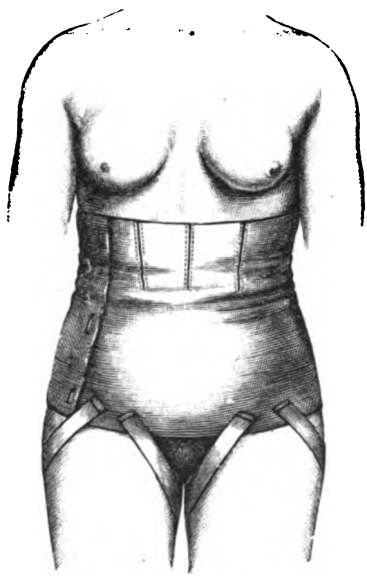

FIG. 36.—BINDER FOR USE AFTER ABDOMINAL SECTION.
(The "goring" of the upper part is optional.)

Each strip is applied while the thigh is flexed, is pinned to the binder over the pubic region, is made to traverse the perineum, and is finally attached again to the binder over the region of the iliac crest (Fig. 36). When the thigh is brought down from the position of flexion, these strips of bandage are rendered tight, and the binder is perfectly fixed in place. A considerable barrier of cotton wool will intervene between the lowest part of the wound and the lower edge of the binder; and if the latter

be well applied, it should be almost impossible to introduce the fingers beneath it.

AFTER-TREATMENT OF THE PATIENT

General Measures.—The patient is usually placed in the supine position, and the knees may be kept a little flexed by placing a pillow beneath them. It is, however, a great mistake to keep all cases of abdominal section rigidly in the horizontal position. When the lower part of the abdomen is being drained the patient's body and head should be placed on an upward incline, arranged by means of pillows. When an appendix abscess has been opened the patient should be nursed lying on the right side. After section performed on an elderly or stout patient the functions of heart and lungs will be much less impeded if the thorax is raised from the first.

A large cradle is sometimes placed over the trunk. It protects the abdomen from the pressure of the bed-clothes, and helps to ventilate the bed. The patient's body is covered by a blanket, which is placed beneath the cradle and in direct contact with the trunk. The rest of the bed-clothes are in two sets, so folded as to meet transversely in the centre of the bed. They are placed outside the cradle, overlapping at its summit. This arrangement permits of the wound being inspected and dressed and enemata, etc., given without disturbing the bed-clothes that cover either the upper part of the body or the lower limbs.

The bed should be well warmed with hot bottles before the patient is placed in it, and hot bottles may be kept in contact with the feet and thorax for some time after the operation.

The patient's movements should be restrained while consciousness is returning, and the nurse may support the abdominal wall with her hands should vomiting occur. The less the patient is interfered with during the first twenty-four hours after the operation the better. Morphia should be avoided whenever possible, and should never be given as a matter

of routine. One-sixth of a grain is sufficient at a time. One injection only will probably be found to be sufficient.

The less taken by the mouth during the first twenty-four hours the better. Nothing whatever need be given by the mouth for the first nine hours. The patient is then allowed hot water or hot weak tea in doses of half an ounce every half-hour or so. Ice is to be absolutely condemned. The reckless and immoderate sucking and bolting of lumps of ice, which is encouraged by the nurse who believes a patient is doing badly who is not constantly swallowing something, is most pernicious. The stomach becomes filled with cold fluid, and a sense of great faintness and discomfort persists until the melted ice is ejected by vomiting.

If really distressing thirst is experienced during the first twenty-four hours, it is best relieved by an enema of warm water. Thirst is such a distressing symptom after abdominal section that it is best to anticipate and prevent its onset by giving a high rectal injection of normal saline solution (one to two pints) directly the patient is put to bed. Many surgeons adopt this as a routine plan. If the operation has been severe and protracted, an ounce of brandy may be given per rectum with the warm saline injection.

During the second day the patient may take hot tea or barley water in small quantities, provided that such fluid does not cause vomiting. There is, of course, no nourishment in tea, moreover it does not suit many patients. Twenty-four hours after the operation, provided there is no sickness, teaspoonful doses of albumen-water or of raw-meat juice may be given every hour. The quantities are gradually increased.

A catheter should be passed when required. It will not be needed during the first twenty-four hours, and the sooner the patient can discontinue its use the better. The practice of passing a catheter by routine once in so many hours is most decidedly to be condemned. As a rule very little urine enters the bladder during the first twenty-four hours after the operation. Nutrient enemata are not needed except in unusual

cases attended with persistent vomiting or after operations on the stomach.

In a case that is doing well the diet from the third to the fourth day may consist of tea and toast, peptonised milk, malted foods, etc. Meat extracts and meat jellies of all kinds are to be avoided. Milk is not usually well borne, and leads to the formation of scybala, while indiscreet perseverance in a slop diet often causes nausea and flatulence. What food is given should be given often and in small quantities. A little fish may be given on the fourth day, and meat on the seventh. Throughout the progress of an abdominal case patent foods are as much to be avoided as patent medicines.

The bowels may possibly act spontaneously. As a rule, however, they do not. In such circumstance an aperient followed by an enema should be administered on the third or fourth day.

The aperient selected should be that which the patient is accustomed to take. Castor-oil is much to be commended. The enema is most important for the purpose of clearing out the lower bowel. It may be repeated if there be any evidence that the rectum is not well emptied. The injection need not be copious ; and in cases where extensive pelvic adhesions have been dealt with, even small enemata often cause distress.

Flatulence or distension of the belly is frequently complained of at an early period after the operation.

It may to some extent be relieved by the use of the "rectum tube." This consists in the vaginal pipe of an ordinary Higginson's syringe, or a large soft rubber catheter. The tube is passed about two or three inches into the rectum, and may be left there for ten or fifteen minutes, or so long as it appears to afford the patient relief. A small receiver must be placed under the free end of the tube, to receive any particles of fæcal matter that may escape.

In these cases of flatulent distension minute doses of a carminative, notably of one of the aromatic oils, often have a very excellent effect, and the same may be said in a lesser

degree of sal-volatile and spirits of chloroform. A hypodermic injection of strychnine ($\frac{1}{60}$ grain) is sometimes useful in overcoming intestinal distension. But probably the simplest and most efficacious measure is to turn the patient on the side for a time. This can often be done with safety, and affords relief to the backache so frequently complained of. A soft rubber tube may be introduced *per rectum*, and left for a time, as it favours the escape of flatus. "One of the best signs of recovery from shock is the power of expelling flatus voluntarily, and where this has been gained, cases practically always do well" (James Swain).

Now and then it will be found that about or before the seventh day after the operation—often about the fourth or fifth—the abdomen is distended, the tongue is coated and foul, the belly is tender, and complaint is made of the tightness of the binder, while there may be a little vomiting or nausea. The temperature remains normal, the respiration unaffected, the complexion unaltered, and the pulse and general condition good. The symptoms in such a case may depend upon the fact that the bowels had not been well evacuated before the operation, or the intestine may have been paralysed by too much opium, or the diet since the operation may have been such as to lead to tympanitic distension. The lavish use of meat extracts or concentrated meat preparations is very apt to be followed by great distension due to decomposition. The patient who presents these symptoms is often greatly relieved by a saline or other aperient. The bowel is well cleared out, and the sickness, the pain, and the distension vanish.

The best aperient is probably a small dose of calomel (two to five grains), followed by one or two drachms of sulphate of soda, given every hour until the bowels act. But when it is inadvisable to give aperients by the mouth—and this is true of many cases of abdominal section—turpentine enemata are most valuable. They should consist of an ounce of turpentine thoroughly mixed with a pint of soap and water, and should be given as hot as is convenient (about 100° F.).

It is possible that cases of this character, relieved in the manner indicated, have been described as examples of acute peritonitis treated by saline aperients. Nor is it doubtful that a certain degree of peritonitis occurs in many cases which recover after abdominal operations—cholecystotomy, intestinal resection, ovariotomy, for example. Flatulent distension and abdominal pain or discomfort (with or without vomiting) may be the only signs of such mild peritonitis. It should be noted that such symptoms usually occur within two or three days of the operation, whilst those due to mechanical obstruction by adhesions or bands come on much later as a rule.

Thrombosis of the veins of the lower limb leading to phlegmasia is sometimes met with after abdominal section, but especially after ovariotomy. It is most apt to occur in patients who are allowed to stand or walk too soon. It should be treated in the usual manner.

Mr. Paget has collected no less than 101 cases of parotitis consequent upon disease or injury of the abdomen or pelvis. This complication is rare after abdominal operations. The trouble appears to be non-pyæmic, and very commonly ends in suppuration. It is possibly due to infection from the mouth along Steno's duct.

After-treatment of the Wound.—The dressing may be removed on the fourth day. The wound should be kept dry. It requires no washing, nor need it be touched with anything moist. The gauze is removed with sterilised forceps, and a fresh dressing applied.

The binder and thigh pieces are once more adjusted.

The sutures should, as a rule, be left in for ten, twelve, or even fifteen days. In other words, a firm scar should have time to form before they are removed. The retention of the stitches will enable the operator to dispense with the subsequent use of strapping.

Throughout the whole period of convalescence the binder should be retained, and be always carefully applied.

Between the third and the fourth week the patient may be allowed to get up.

Such are the times which may be observed in an ordinary case of average severity. In a small proportion of instances it is well that the patient should remain in bed one month, whereas in the simplest exploratory operations the patient may be allowed up on the eighteenth day, or even before. Some surgeons will allow a woman convalescent from ovariotomy to leave the hospital on the eighteenth day. It is well, probably, to err in the direction of encouraging a long period of rest after these operations. Some complications, notably that of phlegmasia, appear to be encouraged by too early movement.

In a few cases, before the patient leaves the surgeon's care, an abdominal belt should be ordered. This should be largely composed of elastic, and may be worn from three to six months. After the simplest procedures a flannel binder is all that is necessary; but in cases of pendulous abdomen, and in instances where the healing of the wound has been imperfect or interrupted, or a very large tumour has been removed, a well-made and very carefully-fitted belt is required.

The primary object of a belt in these cases is to assist the cicatrix in resisting the weight of the viscera and the passive pressure from within. It must be remembered that the abdominal wall is made up of muscular and aponeurotic tissues. It is required that these tissues should not be weakened. Like tissues elsewhere, they atrophy from disuse, and are rendered strong by exercise. The very elaborate, rigid, and heavy belts which are sometimes worn after abdominal section, especially after ovariotomy, may possibly do harm by taking upon themselves too much of the function of the muscles and aponeuroses.

CHAPTER II

OPERATIONS ON THE LIVER, GALL-BLADDER, AND BILIARY DUCTS

I.—Operations on the Liver

Anatomical Points.—The liver is moulded to the arch of the diaphragm. Its convex surface is protected on the right side by the ribs, from the seventh to the eleventh inclusive, and in front by the xiphoid cartilage and the costal cartilages, from the sixth to the ninth inclusive, the diaphragm being interposed.

The liver extends to the left about one and a half to two inches beyond the left margin of the sternum. In the middle line the liver lies close beneath the skin, in front of the stomach, and reaches about half way between the xiphoid cartilage and the navel.

The lower edge, as it crosses the subcostal angle, is represented by a line drawn from the ninth right to the eighth left costal cartilage (Quain). In the erect posture the lower edge on the right side is about half or quarter of an inch below the margins of the costal cartilages. In the recumbent position the liver ascends about an inch, and is entirely covered by the costæ, except at the subcostal angle. It descends also on expiration, and ascends on inspiration; and this disposition to movement must be allowed for when it becomes necessary to stitch a wound in the liver to the parietes.

"The extent of the liver upwards, if traced on the surface of the body, is indicated by a line crossing the mesosternum close to its lower end, and rising on the right side to the level of the fifth chondro-sternal articulation, and on the left to that of the sixth" (Quain).

The right lung lies in front of the liver, as far down as the upper border of the sixth rib, in the nipple line, and the heart

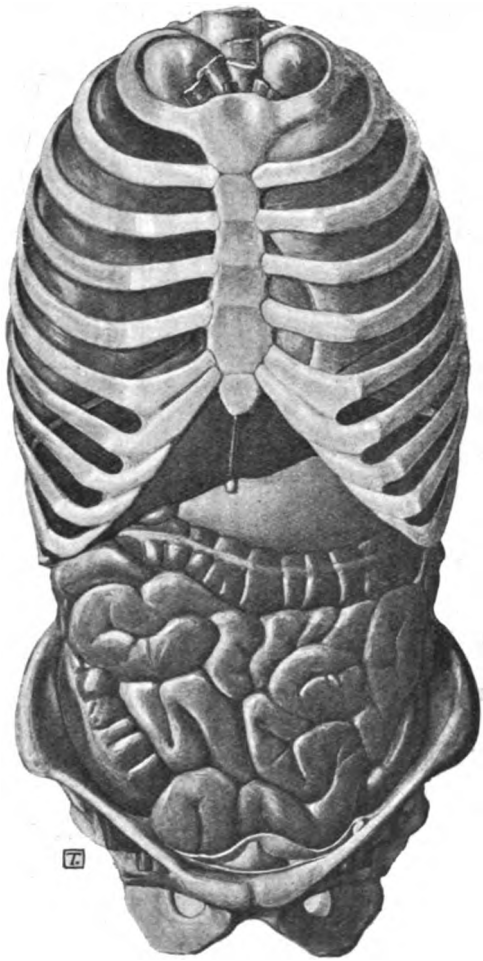

FIG. 37.—RELATIVE POSITIONS OF LIVER, LUNGS, STOMACH, INTESTINES, ETC., IN A NORMAL ADULT SUBJECT. (From a model in the London Hospital Museum.)

Note specially the relations of the gall-bladder, and the hidden situation of the hepatic and splenic flexures of the colon.

as far down as the fifth interspace on the left side. (*See* Fig. 37.)

Behind, the liver comes to the surface below the right lung

at a part corresponding, both in position and width, to the tenth and eleventh dorsal vertebræ. On the extreme right the liver descends to the level of the second lumbar spine (Fig. 37).

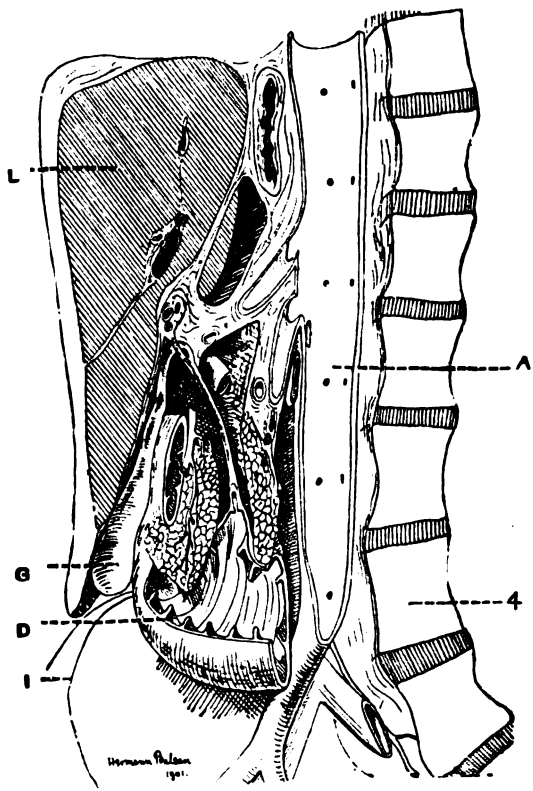

FIG. 38.—SECTION MADE OBLIQUELY DOWNWARDS IN A SUBJECT WITH NEPHRO- AND HEPATO-PTOSIS, TO SHOW THE DISPLACEMENT OF THE DUODENUM AND SHARP BEND OF THE BILE DUCTS. (From a dissection by Dr. Keith in the London Hospital Museum.)

L, Liver; A, Aorta slit open; G, Gall-bladder; I, Iliac bone; D, Duodenum; 4, Fourth lumbar vertebra.

It is needless to say that the relations of the viscus may be greatly altered by diseased conditions, especially by such as are attended with enlargement of the organ, or the development of abscesses or tumours within its substance.

The gall-bladder, when moderately distended, is pear-shaped, and measures about 10 cm. in length and 3 cm. in width at its fundus.

The fundus touches the abdominal wall below the free end of the cartilage of the tenth right rib, and near the outer border of the right rectus muscle.

FIG. 39.—CASE OF DISTENDED GALL-BLADDER. THE DILATED ORGAN FORMS A CYLINDRICAL TUMOUR REACHING TO THE UMBILICUS.

A distended gall-bladder may project downwards to a remarkable extent, and its fundus may then form a tumour which appears to be wholly separate from the liver. It is often seen as low as the umbilicus (Fig. 39), and it has been met with down in the pelvis, so as to be mistaken for an ovarian cyst. It has even been met with in a femoral hernia. On the other hand, a thick shrunken gall-bladder may lie far back under cover of the liver, when its identification from adherent structures (especially omentum) is of considerable difficulty. The largest gall-bladder we have met with (the size of a man's fore-arm and packed with calculi) lay across the right hypochondriac region, so that its fundus was in the loin. When exposed it resembled in appearance an enormous Meckel's diverticulum. Such a position, however, is very rare. Not infrequently, as the gall-bladder becomes distended and descends, a tongue-like process of liver is also drawn out in front of it; this is known as Riedel's or the lingual lobe.

The fibrous coat of the gall-bladder is thin, but is remarkably firm and tough.

The cystic duct is about one inch in length, and turns a little towards the left. It joins the hepatic duct at an acute angle. The common bile duct measures about three inches

(Fig. 40). It descends in the lesser omentum in front of the portal vein, and to the right of the hepatic artery and its gastro-duodenal branch. It enters the right pancreatico-gastric fold behind the first part of the duodenum, and is crossed by the pancreatico-duodenal artery as it approaches and pierces the second part of the duodenum about its middle.

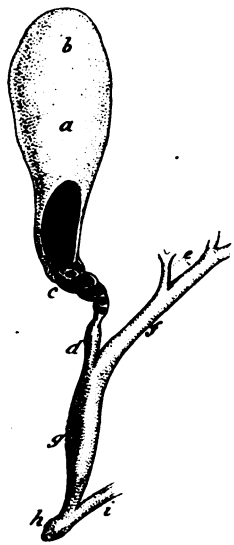

FIG. 40.—NORMAL GALL-BLADDER AND BILE DUCTS.

a b, Gall-bladder; *c d*, Cystic duct; *e f*, Hepatic duct; *g*, Common bile duct; *h*, Ampulla at duodenal orifice into which opens the pancreatic duct, *i*.

Operations.—The following operations will be described in the present chapter :—

Operations on hydatids of the liver.
Operations on hepatic abscess.
Hepatotomy.
Cholecystotomy.
Cholecystectomy.
Choledochotomy.
Cholecystenterostomy.

OPERATIONS ON HYDATIDS OF THE LIVER

The pathology of the cyst-wall in a case of hydatid disease, whether of the liver, lung, or other organ, should be clearly understood, as proper surgical treatment depends upon this knowledge. The true hydatid membrane or endocyst is laminated, non-vascular, and from its inner surface are developed the brood capsules or daughter-cysts (Fig. 41). In exceptional cases the latter are not formed, and the term acephalocyst is then employed; but the hydatid membrane or wall in this case has all the other features of the more common proliferating cyst. The endocyst in the normal condition—*i.e.* when not inflamed or degenerated—adheres but slightly to the ectocyst, which is a layer of fibrous tissue surrounding the true hydatid membrane. The surgeon's aim in dealing with a hydatid cyst should therefore be—

1. To expose the ectocyst and, by incision if necessary, to fix it to the parietes by sutures.
2. After incision of the ectocyst to detach the endocyst, and if possible *to remove it entire with the daughter-cysts.*
3. If, as often occurs, the endocyst breaks during the operation, or has already become inflamed or degenerated, the surgeon should remove by irrigation, etc., all the fragments of membrane and cysts that he can get away.
4. If the entire hydatid membrane has been extracted, and especially if the case is one of acephalocyst, nothing further remains to be done than to insert a drain, and to observe rigid asepsis in the few dressings that will be required before the cavity closes up.
5. If, on the other hand, owing to previous suppuration, etc., it is impossible to remove the entire cyst, and daughter-cysts remain, the operator should provide for free drainage. Daily irrigation with sterile warm water should be practised, and any fragments or cysts that present at the aperture should be assisted to make their exit.

It will be noted that the essential thing during the operation is to remove the endocyst. The fibrous layer outside this is quite harmless, and a futile attempt to dissect it out from such a vascular organ as the liver would certainly be attended by dangerous hæmorrhage. The fingers or a broad sponge-holder serve best for grasping the membrane, which can often be thus twisted or folded on itself so as to facilitate its removal.

The treatment outlined above is, as a rule, the only satisfactory one for hydatid disease, whether of liver, lung, or other viscus.

It is of interest to note that occasionally a hydatid cyst projects from the liver, to which it is only joined by a narrow pedicle. This is shown in Fig. 41, and we have operated on

another similar case. Here, of course, the surgeon has a very easy task: the whole cyst is excised by division of the pedicle, care being taken to stop all hæmorrhage afterwards by pressure and by the insertion of one or two deep catgut sutures through

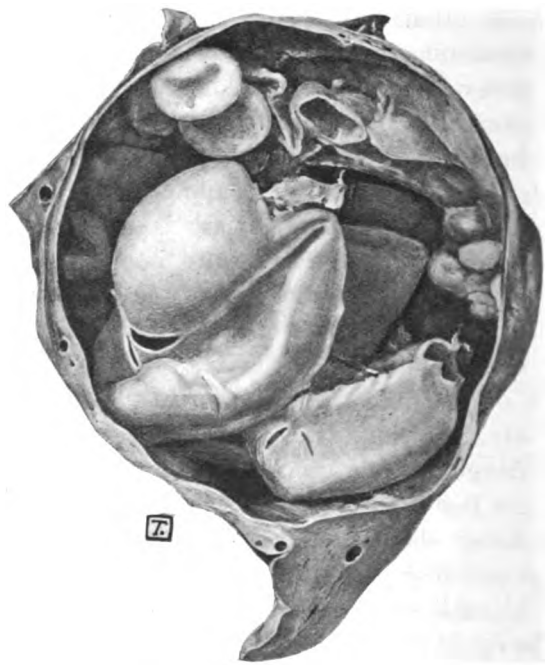

FIG. 41.—LARGE HYDATID CYST EXCISED WITH ATTACHED PEDICLE OF LIVER TISSUE. DAUGHTER-CYSTS OF ALL SIZES ARE SEEN WITHIN THE PARENT ONE. (London Hospital Museum.)

the liver edge. By making a V incision the liver can be neatly sutured so as to leave no raw surface.

Sometimes, besides the main cyst operated on, there may be a number of others disseminated through the same or other organs. This occurred in one case of hydatid of the lung operated on at the London Hospital—one main cyst with daughter ones was removed after partial excision of ribs, etc. The patient died, and upwards of a hundred small cysts were found scattered through both lungs.

Aspiration or *galvano-puncture* as a curative measure should not be resorted to. Even when used for the purpose of diagnosis, aspiration is not without risk, unless the tumour has already been exposed and the surgeon can at once proceed to removal of the cyst.

Amongst the **accidents** that have followed puncture or aspiration in cases of hydatid disease of the liver (real or suspected) the following may be enumerated :—

1. Fatal syncope (many instances).
2. Severe toxæmia from rapid absorption of the hydatid fluid.
3. Peritonitis from leakage of the cyst, sometimes fatal.
4. Puncture of the portal or other large vein in the liver.
5. Wound of and leakage from the gall-bladder into the peritoneal cavity.

The injection of bichloride of mercury or of iodine solution into a hydatid cyst of the liver is dangerous; as a curative measure it is most uncertain.

Site of the Operation.—In the great majority of cases the cyst can be reached from below the costal margin—in fact, it often pushes forward the abdominal wall. Should it mainly ascend beneath the diaphragm, one or two of the lower ribs should be resected.

Treatment by Incision.—The operation may be performed in one or in two stages.

The first deliberate operation upon hydatids of the liver was performed by Tait in 1882. He demonstrated the possibility and also the safety of the method of operation in one stage.

The subject has been very fully dealt with by Dr. W. Gardner, of Adelaide, and others, in the *Transactions of the Second Inter-Colonial Medical Congress* (1889). The monograph on Hydatid Disease by Dr. Thomas embodies an unrivalled experience, obtained in Australia.

1. **Operation by One Stage.**—This measure is termed by some hepatotomy. It involves the opening of the abdominal cavity, the incision and evacuation of the hydatid cyst, and

the suturing together of the margins of the hepatic and parietal wounds.

The skin having been well cleansed, an incision is made over the most prominent part of the tumour. The wound will probably be longitudinal, *i.e.* in the long axis of the body. It should fall upon the abdominal part of the swelling—that is to say, should the most prominent portion of the tumour present in an intercostal space, it should not be incised there, owing to the difficulty of ensuring adequate drainage when the fluid is evacuated between two ribs.

The knife is carried through the parietes, and an examining finger is cautiously introduced into the abdominal cavity. The incision should at first be only about one inch and a half in length. It is extended in whatever direction appears most advantageous after the preliminary digital examination has been made.

The incision may fall upon a spot where the liver is already adherent to the parietes. If so, it is well. Should the digital exploration show that the viscus is adherent to an adjacent part of the abdominal wall, then the incision may be carried in that direction; or another and entirely distinct incision may be made over the adherent area.

In the majority of the uncomplicated cases of hydatids there are no adhesions.

The liver is exposed, and the most convenient spot for evacuating the cyst determined upon. This area is circumscribed by gauze pads or Turkey sponges, which are carefully wedged in all round, so as to prevent the escape of any fluid into the peritoneal cavity.

It will now be convenient to introduce the largest needle of an aspirator, and to withdraw enough of the contents of the cyst to remove all tension. The more fluid removed by the cannula the better, so long as too much time is not expended in the process.

The cyst is drawn as far forwards as possible, the needle puncture is enlarged with a scalpel, and the left fore-finger is

at once introduced into the opening. This digit serves to act as a plug, and at the same time it is a means of hooking or dragging the cyst forwards, so as to bring its opening well into the parietal wound.

The margins of the cyst wound should now be seized by two or more pressure forceps, and by means of these the lips of the cyst wound are drawn forwards, and are kept well approximated to the parietes while the main bulk of the contents of the cyst is escaping. By this means the whole cyst may often be evacuated without any fluid entering the peritoneal cavity.

Hæmorrhage from the hepatic incision may be arrested by sponge pressure, or by pressure forceps; or, failing these, by a continuous suture of fine catgut.

The cyst is now so far empty that no more fluid spontaneously escapes. The opening in the cyst is enlarged as far as is required, and its margins are held by means of additional pressure forceps, as one would hold the mouth of a bag. The finger is introduced, and the interior of the cyst is examined. If possible, the main endocyst should be removed entire by gently detaching it, grasping it with sponge-forceps, and folding it up by a rotation of the latter. In this way, aided by the fingers of the left hand, the cyst wall may be extracted. If, however, suppuration has occurred, or there are great numbers of daughter cysts, the surgeon will trust mainly to free irrigation and the use of mounted sponges. The irrigation should be done with sterile water at a temperature of about 100° F. The whole of the interior of the cyst should be well but gently cleared out.

The mistake should not be made of leaving a second cyst behind. In one case it was only a firm projection of one side of the wall that led us to discover another large cyst, which was incised and drained through the former.

The time is now come for uniting the margins of the hepatic wound to the margins of the parietal incision.

The edges of the cyst wound are still held with forceps,

and into the mouth of this wound a sponge is wedged. The sponges which have been packed around the operation area are now removed, and are carefully counted, as one or more may readily slip out of sight. The peritoneal cavity is cleansed by means of sponges in holders in the usual way (page 106), and to this part of the operation special attention must be paid.

The margins of the opening in the cyst are now sutured to the edges of the parietal wound. The stitches may be interrupted, and of silkworm gut closely applied; or they may be continuous and of silk. Care must be taken that peritoneum is brought in contact with peritoneum. A curved Hagedorn's needle will be found useful in this part of the operation. If the cyst-wall have been firmly secured, the cavity may be further evacuated and cleared out by means of sponges in holders; but all such manipulations must be conducted with the utmost gentleness.

A large drainage tube is introduced and is fixed in position. For large cysts we use a tube with a diameter of one inch. It is useless to attempt to drain a cavity which has contained some pints or quarts with a tube having a lumen of one quarter of an inch.

When subsequent washing out is certain to be needed, a two-way tube is very useful. The advantage of such a tube over the single one is that fluid introduced by means of an irrigator or syringe will not over-distend the cavity.

The wound is dressed with a large pad of moist sterile gauze and wool, secured in place by means of a many-tailed bandage.

The *after-treatment* consists of the frequent washing-out of the cyst cavity, and the maintenance of perfect asepsis and drainage. The fluid used for washing out should have been sterilised by boiling just previously, it should be about the body temperature, and no irritating antiseptics should be used in solution. Normal saline solution, or a weak boric acid lotion, answers best in such a case. A good deal has been written about the treatment of these cysts without drainage, supposing

the contents have been got away. Now and then it may be possible to dispense with the tube, but a large excavation in the liver cannot be expected to close up at once; the process must take a week or more. The drainage tube, provided asepsis is secured and *forced* irrigation through it is avoided, can only be useful. The attempt to dispense with it has often failed.

2. **Operation by Two Stages.**—This operation aims at securing adhesion between the parietal peritoneum and the hepatic peritoneum before the cyst is opened.

The procedure to effect this end constitutes the first stage of the operation. The second stage is undertaken after an interval of some days, and is simply represented by the incising of the now adherent cyst, and the removal of the endocyst and daughter-cysts, followed by drainage.

It is claimed for the measure that it does away with the risks attending the escape of blood or cyst fluid into the peritoneal cavity.

The operation in two stages has been strongly urged by Volkmann, and is often known by his name.

The parietal incision is made, and the parietal peritoneum opened. The cut edges of this part of the serous membrane may then be attached by a few points of suture to the margins of the parietal wound. A dressing of gauze is then applied, so firmly as to keep the abdominal wall as far as possible in contact with the liver.

It is, however, much better to secure the peritoneal covering of the liver to the parietal peritoneum by suture points of fine catgut. These are passed by means of a full-curved needle. Mr. Godlee advises that they be passed pretty deeply into the substance of the liver, and that the stitches be in a double row (Fig. 42, page 139).

The cyst is incised at the end of three, four, or seven days, no anæsthetic being, as a rule, required.

Should it be found, on examination, that stitches will not hold, two courses are open to the surgeon. In the first place he may pass a stitch on each side through the peritoneum and

muscle only, and keep the sides of the incision apart by a tampon of sterilised gauze.

If adhesions are secured, the cyst is opened later; but if no adhesions form, then the following method may be adopted:—The cyst having been exposed, and the abdominal walls pressed against it by means of a circle of sponges, the operator—who must be rapid in his movements—plunges in his knife, and cuts downwards sufficiently to enable two fingers of his left hand to be introduced. He then, by the side of his fingers, inserts four cardinal stitches, and ties them. The remaining steps of the operation are similar to those already described.

Observations and Comments upon the Two Methods.—Hydatid cysts of the liver have been successfully evacuated through the pleural cavity. In fact, if left too long, they frequently burst into the bronchi or pleuræ. This is a dangerous and troublesome complication, and whenever possible a hydatid cyst of the liver should be opened from its abdominal aspect before it has invaded the chest.

However, if the cyst bulges upwards into the thorax it will usually be found best to excise subperiosteally two or three inches of the ribs immediately over the greatest projection. The two surfaces of the pleural cavity should be stitched together if possible before incising the diaphragm or cyst wall. The diaphragm itself may be much thinned or perforated by the cyst wall, and it is then by no means easy to recognise.

(For an account of the removal of hydatid cysts *en masse*, *see* page 130.)

Of the two methods above described, the direct method by one stage is without question the more satisfactory, and carries with it no particular or unnecessary risk. In other words, it has not been shown that the precaution which is characteristic of the method by two stages is well founded. The risk attending the escape of hydatid fluid into the peritoneal cavity has been much exaggerated.

This latter method somewhat narrows the area of the surgeon's movements; when no sutures are applied, the extent

and the stability of the adhesions are subject to variation, and those which are formed may not suffice to shut off completely the peritoneal cavity. The surgeon is acting a little in the dark. The attachment of the cyst wall to the parietes is not at once so firm as that which is secured by sutures, and the complete clearing-out of the contents of the cyst cannot be so safely effected. Above all, much time is lost. This may be a matter of little moment in the case of a hydatid cyst, but it may be of paramount importance in the case of a hepatic abscess.

There is another grave objection to the two-stage method. If, as suggested, the incision of the cyst is made without giving a second anæsthetic, the procedure is an alarming and perhaps painful one to the patient. The necessary manipulations in clearing out the cyst, etc., are much better done under complete anæsthesia.

If care be taken during the one-stage operation, the risk of the escape of septic fluid into the peritoneal cavity is reduced to a minimum; and it must be distinctly understood that that risk is not done away with entirely in what is known as Volkmann's operation, especially when the second stage is carried out at so early a period as the third or fourth day, and no sutures are employed.

The direct operation by one stage may claim to be the more thorough and the more satisfactory, and to effect with more completeness the object the surgeon has in view.

It does not appear that these advantages are discounted by any unusual or special risks.

OPERATIONS ON HEPATIC ABSCESS

What has been said about the treatment of hydatids of the liver may be said of hepatic abscess.

It should be noted that multiple small abscesses scattered through the liver (from pyle-phlebitis) are not worth operating on. It is only when one or two abscesses are present that cure can be expected from the surgeon's intervention. This should

take place as soon as ever a probable diagnosis can be made. An exploratory incision with puncture by an aspirating needle into the liver is not very dangerous, whereas an abscess, if left too long, may destroy almost the whole liver and render the prospect hopeless. Of this we have seen several instances.

The abscess may be opened in three ways :—

1. **By Direct Incision,** when the abscess is "pointing," and when from the local tenderness, redness, and œdema it is evident that adhesions exist, and that the pus is close under the skin. This measure needs no further comment.

2. **By Incision and Drainage carried out at One Sitting.** —The method observed is precisely similar in all points to that already described in connection with hydatid cysts (page 131). If care be taken, and if the operation be conducted upon the lines laid down, there is little danger of any pus finding its way into the peritoneal cavity.

It is best to approach an hepatic abscess through the abdominal wall when practicable. The abscess is usually situated in the right lobe, and may bulge into the thorax or the lower intercostal spaces. Should the operator decide to evacuate it through the chest wall, two inches of one or two lower ribs should be incised, keeping as far back as is convenient. The pleural cavity will very likely not be opened, either from its not reaching so low, or from inflammatory adhesions having obliterated it. If, however, the incision is found to be a healthy pleural cavity, the entrance of air can largely be prevented by a few deep sutures through diaphragm and outer layer of pleura which circumscribe the area through which drainage is to be carried out.

After the abscess has been evacuated, a gentle examination of its interior may be made, to ascertain if another abscess or cyst exists. The abcess cavity should be cleared out by means of a soft sponge in a holder. The manipulation must be gentle, as the abscess wall is readily damaged, and bleeding ensues.

The after-treatment of the case is the same, the main points

being free drainage, frequent and free flushings-out with the irrigator, and the use of antiseptic measures throughout.

For the purpose of irrigation a double or two-way rubber tube is the most suitable. It should be noted that some liver abscesses, especially the "tropical" ones due to the *Amœba coli*, contain pus which is practically free from bacteria. In such cases irrigation is hardly necessary, and the abscess may be drained by a single long tube, the end of which is placed in a bottle containing some antiseptic lotion. A syphon action can thus be established; at the same time the dressings next the wound are kept dry.

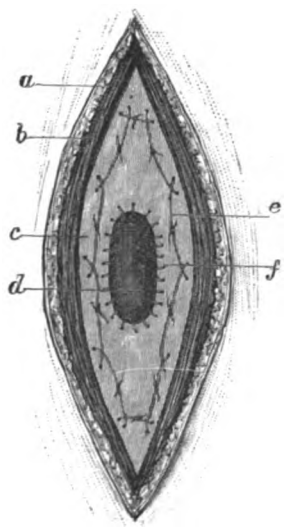

FIG. 42.—METHOD OF ATTACHING THE LIVER TO THE PARIETES. (*Godlee.*)

a, Subcutaneous fat; *b*, Rectus; *c*, Sheath of rectus; *d*, Liver; *e*, Interrupted suture; *f*, Continuous suture.

3. **By Incision and Drainage carried out in Two Stages.**—The proceeding employed is precisely identical with that already described in the account of hydatids of the liver (page 135). The best method is that employed by Mr. Godlee. This will be understood by reference to Fig. 42. A double row of sutures is passed through the rectus sheath and peritoneum on the one hand, and the subjacent liver capsule and tissue on the other. The outer row should be interrupted sutures, the inner continuous.

It has been pointed out that in dealing with the parasitic cyst, this method in two stages has no very great advantages. The same observations may apply to the case of hepatic abscess.

In addition to such objections as have been already formulated, the following may be noted:—

The adhesions which form, when no sutures are employed, may be insignificant, and may cover but a very small area. When the incision is made, that area may be easily transgressed.

Such adhesions cannot be firm until many days have elapsed, and this delay may prove a serious matter in the case of an abscess which is rapidly approaching the surface. Moreover, after adhesions have been secured, the abscess may show signs of pointing at another spot distant from the intended site of the incision. If Mr. Godlee's method be adopted, these objections cease for the most part to hold good. Mr. Godlee has shown that if the sutures are introduced in the manner described, the abscess may be at once opened, and all delay thus avoided.

Observations and Comment.—The method by free incision at one sitting offers undoubtedly the best means of dealing with hepatic abscess. Attempts to open the abscess by means of the actual cautery are to be condemned. The aspirator is only of use as an aid to diagnosis, and as a palliative means. Its employment has frequently compromised the success of a subsequent operation by free incision. There is nothing to recommend the common plan of tapping the abscess with a trocar, and of draining it through the cannula, or through a drainage tube introduced through the cannula, and left in place of the latter.

The drainage thus secured is very inefficient, pus may leak out into the peritoneal cavity, the surgeon makes the thrust with the trocar in the dark, and important structures may be punctured; the cannula may slip, and the measure would not meet a case where multiple abscesses exist. This apparently slight operation is—like most timid, speculative, and meddlesome half-measures—much more dangerous than the complete operation. It must be allowed, however, that this method has been advocated by Sir Patrick Manson and Mr. Cantlie, both of whom are authorities on tropical diseases.

A valuable series of lectures on hepatic abscess, published by Mr. Godlee in the *British Medical Journal* for January, 1890, should be consulted by those who are interested in this branch of surgery. To the following points in these lectures especial attention may be directed :—

Mr. Godlee demonstrates by means of an illustrative case that even when an abscess is actually "almost pointing," it is impossible to be certain that the liver will be found to be adherent. In the case quoted there were no adhesions.

Several of the cases illustrate the evacuation of the abscess through the chest wall. It is urged that in these cases the incision should be made below the normal limit of the pleura; but that if by chance either pleura or peritoneum be opened, the opening must be closed with a double row of stitches before the liver is incised.

In one illustrative case an exploring needle had revealed the presence of deep-seated pus in the chest. An incision was made over the ninth interspace and a portion of the ninth rib was removed. The diaphragm was then stitched with some difficulty to the costal pleura, and the abscess was opened by cutting through the attached diaphragm. The patient made a good recovery.

In another case, in which the abscess was opened through the seventh intercostal space, profuse hæmorrhage occurred.

In a third case, in which an incision was made into the abscess through the seventh or eighth space at the lower part of the axilla, "terrific hæmorrhage" attended the enlargement of the opening into the abscess.

PARTIAL EXCISION OF THE LIVER (HEPATOTOMY)

In cases of lacerated wound of the liver a portion of the viscus has been sometimes excised with success, and occasionally a new growth (adenoma, cystic adenoma, or cancer) is so localised that its excision is justifiable. Mr. Mayo Robson has recorded several cases in which a malignant growth of the liver (sometimes including the gall-gladder) has been removed. Mr. W. W. Keen (*Boston Med. and Surg. Journ.*, April 28th, 1892) has collected twenty cases of partial hepatectomy, several of them represented by examples of gumma, hydatid cyst, or constricted lobe. For neither of these can excision be really indicated, as other treatment would be safer and more appropriate.

The prognosis after excision of a cancerous portion of liver is deplorable; a few months' continuation of life is all that can be expected, and it is more than doubtful if the operation materially lengthens it. Moreover, the "convalescence" after such an operation is usually slow and painful, a biliary fistula being probable. We strongly dissuade against heroic operations of this kind, and we regard the deliberate excision of hepatic gummata as both unwise and involving needless danger to the patient. In more than one case of the kind the operation has ended fatally.

In any suitable case the part excised should be in the form of a wedge, with its base at the free border of the liver, and after checking the hæmorrhage the two raw surfaces should be brought together by catgut or kangaroo tendon sutures, which take a deep hold of the liver substance. Pressure on either side of the section exerted by the assistant, who grasps the liver edge between finger and thumb, sponge pressure on the bleeding surface, direct ligature of cut vessels, and the use of adrenalin solution applied on a sponge, are all useful in checking the hæmorrhage before the sutures are tightened.

Many elaborate methods of suturing the liver are described and figured in Lejar's "Chirurgie d'Urgence," Moynihan's "Abdominal Surgery," and elsewhere. Their number and complexity are out of all proportion to their practical utility.

The thermo-cautery and the elastic ligature have also been used in some cases, but as both involve a sloughing surface in the liver, they should be avoided.

Dry sterilised or iodoform gauze should be packed round the wound of the liver, and ample provision allowed for drainage. The risk of ventral hernia is slight in this region.

The gauze should be removed in two to three days' time, and replaced by a smaller amount for drainage purposes.

Saline injections *per rectum* and strychnia should be given freely if the operation has been attended by much loss of blood. In several such operations hæmorrhage has been the direct cause of death.

II.—Operations on the Gall-bladder and the Main Bile Ducts

Anatomical Considerations.—The gall-bladder, pyriform in shape, lies in a shallow groove on the under surface of the liver, to which it is fixed in part by the peritoneum, by cellular tissue, and by numerous small blood-vessels. Its fundus or anterior end is usually covered wholly by peritoneum, and projects slightly at the anterior edge of the liver, being situated opposite the tip of the tenth right costal cartilage and immediately behind the abdominal wall. When distended, its fundus may be found much below this spot, to the right of the umbilicus, or even still lower. (*Compare* Figs. 37 and 39.)

When moderately full, the normal gall-bladder holds some 50 to 60 grammes of fluid, or about two ounces, but is capable of great distension. On the other hand, as the result of inflammation it is sometimes met with as an almost solid viscus with a very small cavity.

The long axis of the gall-bladder is directed upwards and backwards; in cases of downward displacement of the liver the direction may be almost directly upwards, and its axis will then form a sharp angle with that of the cystic and common bile ducts (*see* Fig. 38).

When not displaced, the under surface of the gall-bladder rests on the pylorus or commencement of the duodenum and the hepatic flexure of the colon. In one out of every six cases there is a fold of peritoneum connecting it with the colon (the cysto-colic ligament).

The neck or narrow end of the gall-bladder is somewhat sinuous, curving from below upwards and from right to left, then directly backwards to the commencement of the cystic duct. This curved portion, like the greater part of the gall-bladder, is fixed to the liver by peritoneal folds. As seen in Fig. 40, at this point there are several valvular folds of mucous membrane corresponding with depressions on the outer surface,

and beyond these the actual commencement of the cystic duct is narrowed.

Hence calculi are apt to become tightly impacted at this level. For the same reason—the tortuosity of the cystic duct and the presence in it of valvular folds—it is usually impossible to pass a probe or bougie along the duct from the gall-bladder. If, however, the duct has become dilated and straightened from backward pressure, or by the passage of calculi, this may be possible.

The vesical neck is in close contact with the right branch of the portal vein and below with the duodenum. The cystic duct, which varies from one to three inches in length, passes downwards in the gastro-hepatic omentum immediately in front of the portal trunk, to the right of the hepatic artery, being joined very obliquely by the main hepatic duct. The latter is somewhat larger, thicker, and longer than the cystic duct; it has no valvular folds. Hence calculi, though frequently met with loose in the hepatic duct, are rarely impacted there. The common bile duct, about three inches in length, passes obliquely downwards, slightly backwards, and to the left, to open in common with the pancreatic duct into the second part of the duodenum. It lies at first for about one inch in the gastro-hepatic omentum just at its free or right border, and is crossed usually in front by the pyloric and right gastro-epiploic arteries. It is in this comparatively free portion, increased perhaps by drawing the first part of the duodenum downwards, that the common bile duct is mainly accessible to the surgeon. Through an incision made in its long axis, after division of the peritoneum over it, suitable forceps may be passed down into the lower and protected portion of the duct. The latter runs behind the duodenum and in a groove of the pancreas, and is very closely applied to both organs. Almost always the duct is deeply imbedded in the substance of the pancreas. Before its narrow valvular opening into the duodenum (which is situated on the inner and posterior aspect of the latter just where its vertical or second portion ends) there is a slight dilatation (the ampulla

of Vater). The opening is marked by a papilla (Fig. 43), which may be found readily on opening the vertical part of the duodenum. If a large calculus or a number of small ones have lodged in the ampulla, the papilla will become more conspicuous. The main pancreatic duct (humorously termed by German writers the Wirsungianus) does not always open into the ampulla as shown in Fig. 43. It "not infrequently opens separately from the common bile duct" (Quain); in fact, Büngner found that the two ducts only unite before the papilla in 1 or 2 per cent., that almost without exception there are two separate orifices on the papilla. The point is of some practical importance in exploration of either duct from the duodenum.

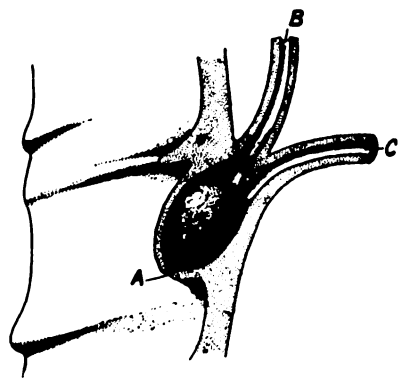

FIG. 43.—SECTION OF DUODENAL WALL, SHOWING AT A THE PAPILLARY OPENING OF THE BILIARY AND PANCREATIC DUCTS (B AND C). A CALCULUS IS FIRMLY LODGED IN THE AMPULLA OF VATER.

Those who have only seen the common bile duct in anatomical specimens can hardly realise the size and thickness it is capable of attaining owing to long obstruction. In many cases it has been found to have the diameter of the small intestine of an adult, and in one case operated on by Mr. F. S. Eve in the London Hospital, the dilated duct would have held one's hand.

The common bile duct in its lower portion has occasionally been reached from an incision in the loin, but the ampulla is more easily approached from in front through an incision in the descending portion of the duodenum.

From the preceding it will have been noted that both where the cystic duct passes into the gall-bladder, and at the lower end of the common bile duct, there are conditions specially favouring the impaction of gall-stones. It is well in operating to bear this fact in mind.

CHOLECYSTOTOMY

By this operation is meant the making of an incision into the gall-bladder through a wound in the abdominal parietes.

Its chief indication is for the removal of gall-stones, whether impacted or not. It is also performed in cases of cholecystitis, in simple hydrops or distension with mucus of the gall-bladder—both conditions usually due to impacted gall-stone, but possibly to other causes, such as typhoid fever, hydatid cysts, or obstruction from growths at the transverse fissure. Cholecystotomy has frequently been performed in cases of jaundice due to malignant disease of the liver, gall-bladder, or pancreas; but the universal testimony is that under these conditions the operation only hastens the inevitable end, and that it should not be performed. In some cases of chronic pancreatitis, however, as Mayo Robson has proved, drainage of the gall-bladder by cholecystotomy has a beneficial effect, and may even lead to cure. The operation has been successfully carried out in certain cases of wound or perforation of the gall-bladder, and in one instance at least the gall-bladder was opened, and a temporary biliary fistula established, in order to relieve extreme congestion and enlargement of the liver (*Bull. de l'Acad. de Méd.*, Nov. 4th, 1890). The terms cholelithotomy and cholelithotrity have been employed in instances in which gall-stones have been removed by cutting, or have been crushed *in situ*.

History of the Operation.—So long ago as 1733 Petit suggested the possibility of dealing with certain disorders of the liver by surgical means; and in a memoir published in 1743 he suggests that the distended gall-bladder should be relieved by puncture, and that stones lodged in that viscus should be removed by lithotomy (*Mém. de l'Acad. Roy. de Chir.*, 1743, page 163). Operations upon the gall-bladder were discussed in a casual and flighty manner during the early part of the last century, but it was not until 1867 that the modern operation of cholecystotomy was first performed. The operator was Dr. Bobbs, of Indianapolis. The patient recovered (*Trans. Indiana State Med. Soc.*, 1868, page 68). Dr. Marion Sims appears to have performed the second recorded operation (*Brit. Med.*

Journ., 1878, vol. i., page 811). The patient died, but Dr. Sims' paper may be said to have laid the foundation for the performance of the operation in Europe, since he detailed with great clearness and precision the various steps of the procedure. The first successful operation in England was performed by Lawson Tait on August 23rd, 1879 (*Med.-Chir. Trans.*, vol. lxiii., page 17). Tait adopted Dr. Sims' plan, and in subsequent cases he further elaborated the operation and extended its possibilities. The operation as now practised may be said to be a most successful one, and the mortality is probably not higher than 5 or 6 per cent.

Hans Kehr, in a monograph on the subject (*Volkmann's klinische Vorträge*, No. 225, 1898), records the results of 327 cases of gall-stone operated on by himself, with twelve deaths—*i.e.* 3·8 per cent. In his valuable works on gall-stones Mayo Robson gives a similar percentage.

Condition of the Gall-Bladder.—From a surgical point of view gall-stones may be divided into two classes—(1) the solitary, and (2) the numerous. The former are seldom more than two or three in number, and may be of considerable size. They are liable to block the cystic duct, and lead to great distension of the gall-bladder, but not to jaundice, since bile still finds its way along the common duct into the duodenum.

Those of the latter class are small, and may be present in hundreds. As they allow some bile to trickle by them, jaundice may be absent, and the distension of the gall-bladder is usually intermittent.

The distended gall-bladder may attain enormous proportions, may contain some pints of fluid, and may even so far occupy the abdominal cavity as to be mistaken for an ovarian cyst. The gall-bladder, as it enlarges, tends to follow a line extending from the tip of the right tenth cartilage across the median line of the abdomen below the umbilicus. (Fig. 39, page 127.)

The distended viscus may be pyriform, globular, or cordiform in outline. It may be hard and firm, or soft, or semi-elastic. The tumour, if of no great size, moves with the liver on respiration.

On the other hand, the gall-bladder may be so shrunken

as to be scarcely recognisable. It may be completely hidden by adhesions, and these adhesions may be sufficiently wide-extending entirely to confuse the anatomy of the district. A small gall-bladder has been found to be enclosed by adherent omentum and intestine, and is not unfrequently hidden by an enlarged liver. The walls of the bladder may be thin in one case, and very hard and thick in another.

Stones may be discovered to be impacted in either the cystic or the common duct, or in both at the same time.

Some surgeons have advised a preliminary sounding for gall-stones by means of a needle; the practice, however, must be condemned as uncertain, unsatisfactory, and decidedly unsafe. An extensive examination of the region of the gall-bladder by means of a needle is a more dangerous proceeding

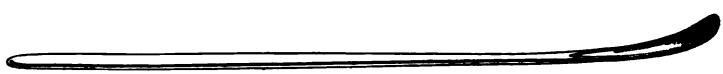

FIG. 44.—SCOOP FOR EXTRACTION OF GALL-STONES, MADE OF SUCH SOFT METAL AS TO BE READILY BENT BY THE FINGERS.

than an exploratory incision, and we cannot imagine any case in which it would be justifiable.

Instruments Required.—Scalpels; bistouries; dissecting, artery, and pressure forceps; long-bladed dissecting forceps; large pressure forceps for extensive adhesions, *e.g.* of omentum; rectangular retractors; spatulæ; blunt hooks; scissors; intestinal and other curved needles; needle-holder; sponge-holders; special scoops (Fig. 44) and forceps for dealing with the calculi (the scoops should be more flexible than the ordinary lithotomy ones); Lister's sinus forceps; long probe; aspirator or trocar and cannula. A firm pillow or large sand-bag should be at hand.

The Operation.—The general management of the operation, the preparation of the patient, the position of the surgeon and his assistants, conform to the lines already laid down in dealing with abdominal section. Great assistance will be obtained in exposing the gall-bladder region by having a large

sand-bag placed behind the patient's loins, so as to lift up and render convex the epigastrium.

The parietal incision is about three inches in length, and can be enlarged as required. It is best made vertically over the most prominent part of the tumour, when one exists, or over the fundus of the gall-bladder when no swelling is evident.

It is easy to enlarge this vertical incision, which is placed in the linea semilunaris or the substance of the rectus muscle, by two nearly transverse shorter cuts at either end; the upper one encroaches on the rectus muscle, the lower passes outwards, so that the whole becomes a sigmoid incision. (*See* Fig. 32, page 90.)

The peritoneum is opened, and the two edges of its cut surface with the adherent sheath of rectus are grasped with Wells' forceps on either side to act as retractors.

The wound is enlarged as required. Intestine may protrude and hamper the surgeon's movements, or the omentum may be found in the way, or an enlarged liver may overshadow the operation region. If the gall-bladder has been inflamed for long, the great omentum is almost certain to be adherent to it, and these adhesions must be carefully separated. If necessary, part of the omentum should be ligatured and excised. Adhesions to the duodenum, colon, or stomach should be treated with respect, as one or more fistulæ may be present. The most dangerous condition is where there is a small abscess beneath the neck of the gall-bladder due to perforation of its wall by a calculus (acute peritonitis may be present without actual perforation). In the great majority of cases, however, the adhesions are with patience and care easily separated. Any bleeding vessels in them should at once be tied. In cases of simple hydrops there are no adhesions to deal with.

The aim of the surgeon is to clear and expose the gall-bladder and ducts as far as possible before opening the former.

The gall-bladder and the cystic and common ducts should then be palpated (if necessary, the left index finger is passed through the foramen of Winslow), in order to ascertain the exact

position of any calculi. In many cases the surgeon will be aided by the assistant grasping the free edge of the liver and drawing it upwards and forwards. By this rotatory movement the ducts are made more prominent and accessible. The next step preliminary to opening the gall-bladder consists in packing the spaces around it with gauze pads or flat sponges. The chief one is placed deep in the hollow over the right kidney, another protects the intestines below, and a third one may be required over the stomach.

When the gall-bladder is much distended it bulges through the wound so that its incision, etc., can be carried out outside the abdomen.

The fundus of the gall-bladder is now aspirated. The site of the needle puncture is protected by sponges, which are wedged in position. As the cyst is emptied, its wall is gradually and gently brought into the parietal wound. This is not always an easy matter, and as the cyst-wall is often very thin, it must needs be handled with great gentleness.

Care must be taken that no fluid escapes into the peritoneal cavity.

The wall of the gall-bladder is best held and drawn forwards by means of pressure forceps. The amount of traction exercised must be very judiciously regulated. The wall of the gall-bladder is then opened by an incision made between the retaining forceps, all bleeding points are dealt with, and the forceps are readjusted so that the cyst may be drawn well forward, and held in position between the lips of the parietal wound. By means of properly-applied sponges the escape of fluid into the peritoneal cavity is prevented.

The finger introduced through the opening feels for the stones, notes their position, and ascertains the best means for removing them. Loose stones may be removed with the finger, or by means of scoops or forceps of suitable size and pattern. Long and slender scoops—aided by a finger outside the gall-bladder—are more useful than forceps.

Inasmuch as the walls of the bladder are thin and often

weak, the greatest care must be exercised in this, the most difficult part of the operation.

In dislodging stones, Tait's special forceps (Fig. 45) are occasionally of service, and their movements within the bladder may be guided by the fingers introduced into the abdomen, and placed against the outer wall of the cystic duct or neck of the gall-bladder at the site of the impacted stone.

Sometimes the stone may be prised upwards by means of the finger so introduced. Mr. Moynihan points out that an

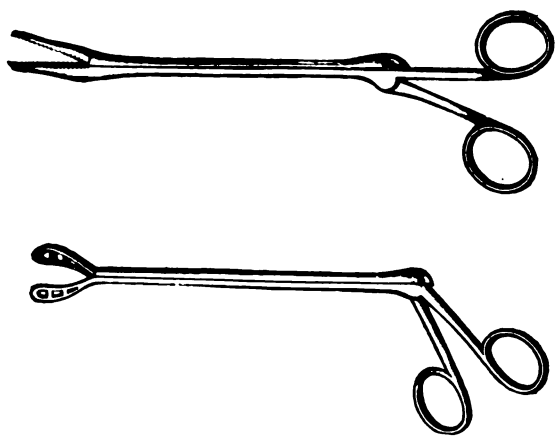

FIG. 45.—TAIT'S CHOLELITHOTOMY FORCEPS.

impacted stone can be more readily pushed back when the gall-bladder still contains much of its fluid contents. As a rule, however, when this difficulty is met with, the viscus has already been opened and emptied.

If the calculus cannot be dislodged, then it may sometimes be very slowly and cautiously chipped into fragments by means of forceps, the action of which is controlled by the finger outside the gall-bladder.

In some cases the impacted stone has been broken up by means of forceps, the blades of which are padded with india-rubber tubing, applied to the stone outside, and therefore through

the walls of the neck of the gall-bladder, or by pressure between finger and thumb.

The detritus which results from these procedures is got rid of by repeated washings.

Attempts to push the stone onwards through the duct by means of a probe or director have not met with much success. The proceeding also is not free from risk, and is to be condemned.

In some cases the surgeon has succeeded in dislodging an impacted calculus in the cystic duct by means of frequent syringing through the fistulous opening after the operation had been completed.

It is, however, unsatisfactory to leave an impacted calculus in either of the ducts; it is better to remove it by direct incision. Cholecystectomy, *i.e.* excision of the gall-bladder, with the stone still impacted, may be indicated in such a case. The operator should do his utmost to convince himself that all obstacles in the way of the bile-flow are removed before completing the operation. The regurgitation of healthy bile is a conclusive sign that the cystic and hepatic ducts at least are free.

The treatment of such stones as are impacted so low down in the duct as not to be reached from the gall-bladder is dealt with in a later section (page 161).

The cavity of the gall-bladder is now gently cleaned by small sponges or holders, or if calculus *débris* is present, by irrigation with a syringe to which is fitted a rubber tube.

The operator has ascertained now that the ducts as well as the gall-bladder are clear, and the pads at first introduced around them are removed and counted. A moist swab is used to clean any blood-clot, etc., away.

Bile can be prevented from escaping by a sponge on a holder introduced into the gall-bladder, or by crossing the Wells forceps which hold the edges of its wound.

Provision of Drainage.—In the early days of the operation the wound in the gall-bladder was sutured to the skin, later

it was secured to the deep part of the wound (muscle and peritoneum). Both methods have been generally abandoned in favour of leaving an opening just large enough for a long rubber tube to pass through. The tube need not be large; about one centimetre in diameter will suffice. Two inches or more of the tube are left in the gall-bladder, to the wall of which it is secured by a catgut stitch, the rest of the tube is subsequently packed round with the dressing, and ends in a bottle conveniently placed at the patient's side.

The tube is fixed in the following manner: The linear wound in the gall-bladder is trimmed if necessary, and a continuous catgut suture is passed through the outer coats from either end, leaving a central aperture through which the tube is placed. The same suture or a separate one is then passed through the rubber tube, so as to keep it in close contact with the wall of the gall-bladder, and to convert the linear wound into a small circular one. In addition, a purse-string suture may be introduced around and one centimetre distant from the tube; when this stitch is tightened it tucks in the opening so as to make it valvular. The method is similar to that employed in gastrostomy (*see* Fig. 52, page 179). If the suturing has been well done, there can be no leakage at the side of the tube. If the sand-bag behind the loins has not been already removed this should now be done in order to facilitate *the closure of the abdominal wound.*

This is carried out by a continuous (fairly stout) catgut suture, which traverses the peritoneum and posterior layer of rectus sheath. If the gall-bladder will come in contact with the parietal peritoneum, and it usually will do so, it is fixed to it by two catgut or fine silk sutures. These may be part of the continuous stitch already described.

The higher up the gall-bladder is placed—*i.e.* the nearer to the costal margin—the better. A few interrupted sutures of silkworm gut are made to traverse skin, anterior layer of rectus sheath, and the muscle itself. It is often convenient to leave one or two of the latter sutures, those close to the gall-

bladder itself, loosely secured for a day or two. This leaves room for a small gauze packing if the surgeon is doubtful as to the security of his gall-bladder suturing.

When the viscus is so contracted that it cannot be stitched to the parietes, the tube is fixed in the manner described and the region in front of the gall-bladder drained with another tube and some gauze. A light dressing of sterilised gauze and wool is finally applied over the wound, the binder or bandage round the abdomen being so arranged that the rubber tube is not obstructed.

The nurse should see that the patient does not displace or drag on the tube, and that the bile can freely escape into the glass receptacle provided for it outside the patient's bed.

After-treatment, and Comments on the Operation.—The drainage tube is left undisturbed until it becomes loose, which will usually happen within a fortnight. It is then removed and in many cases the fistula quickly closes. In a certain proportion of them, however, either bile or mucus continues to leak out for a long time. This is the great drawback of the operation, and may be due to small stones having been left in the common duct.

In one of our cases calculi were removed at the same operation from both gall-bladder and common duct; a firmly impacted calculus was also extracted by incision from the main hepatic duct. To have been content with cholecystotomy in such a case would in no way have relieved the patient.

During the operation the gall-bladder should never be fixed to the parietes before it is opened, as this would hamper the surgeon in dealing with any calculi that are deeply impacted.

For simple cases, *e.g.* where there is a single large stone in a healthy but distended gall-bladder, the operator would naturally be inclined to remove the calculus and to close up the wound entirely without drainage, thus avoiding the formation of a fistula. This method, known as "ideal cholecystotomy," has been practised by Küster, Roux, Czerny, and a number of other surgeons. It has, however, been condemned by some

writers, perhaps without sufficient reason. We have performed "ideal cholecystotomy" in several cases with good results. The linear wound in the gall-bladder is carefully sewn up with a double row of catgut or fine silk sutures, the first (a continuous one) closing the mucous membrane, the second (either continuous or interrupted) taking in the peritoneal and middle coat of the gall-bladder. A gauze and tube drain should always be placed opposite the sutured line in case of subsequent leakage. The chance of this occurring is one strong reason against the operation, which has unfortunately been followed by peritonitis in some cases. Another argument against it is that it may be better to remove the gall-bladder, in which calculi may form in the future.

CHOLECYSTECTOMY—EXCISION OF THE GALL-BLADDER

This operation was proposed by Langenbüch in 1882. In the treatment of cases of gall-stones with complications it was first carried out freely by Hans Kehr, and it has come of late so much into favour as to be proposed almost as a routine measure. Thus Byron Davis, writing in 1903, urged that cholecystectomy should be performed in every case in which the patient's condition did not require the operation to be as short as possible.

On the other hand, Czerny rarely practises it, considering that drainage with suspension of the gall-bladder is safer, except in cases of inflammatory necrosis of the viscus.

The following points may be noted :—

After cholecystotomy with drainage for biliary calculi a certain number of patients are not wholly relieved (the proportion has been stated as high as 20 per cent.). This failure may be due to small calculi being left behind, to fresh calculi forming, to the persistence of a biliary fistula, to adhesions of the gall-bladder, etc.

Excision of the gall-bladder removes the chief seat for the formation of calculi, and the patient is none

the worse for the removal of an unimportant (useless ?) organ.*

The mortality attending excision of the gall-bladder (2 per cent., Kehr) is not appreciably higher than that of cholecystotomy.

On the other hand, the latter operation is, as a rule, considerably the shortest, though the subsequent convalescence is considerably protracted. After a successful cholecystectomy, the patient may be perfectly well at the end of a fortnight.

No absolute rule can be laid down to determine the surgeon in his choice between the two operations. Until the abdomen is opened and the gall-bladder isolated, he cannot decide whether it is wise and safe to perform cholecystectomy or to be content with extraction of the stones and drainage. The following are the chief indications for the radical operation :—

1. A greatly thickened gall-bladder.
2. Ulceration of the mucous membrane of this viscus, especially if widespread or accompanied by calculous deposit.
3. Stricture or obliteration of the cystic duct.
4. The presence of calculi, impacted in the cystic duct, which cannot be removed through the cholecystotomy wound.
5. Empyema of the gall-bladder or gangrenous inflammation of its walls.
6. Long persistence of a biliary fistula after drainage. This may, however, indicate another stone in the common bile duct, which will require removal.

A new growth (adeno-carcinoma), limited to the gall-bladder, is an obvious indication for cholecystectomy, but such cases are very rare. We have excised the gall-bladder with a wedge-shaped piece of the liver above it in one case in which the in-

* Cholecystectomy prevents the risk of cancer of the gall-bladder following, at a considerable interval, removal of gall-stones. This risk, though small, is a real one, and we have known one case of its occurrence.

tration was apparently limited. It was doubtful if the operation prolonged life, death resulting from widespread cancer of the liver three months later.

To the indications for cholecystectomy given above, F. S. Eve (*Clin. Journ.*, May 2nd, 1906) adds simple dilatation of the gall-bladder. This is commonly due to a single large stone

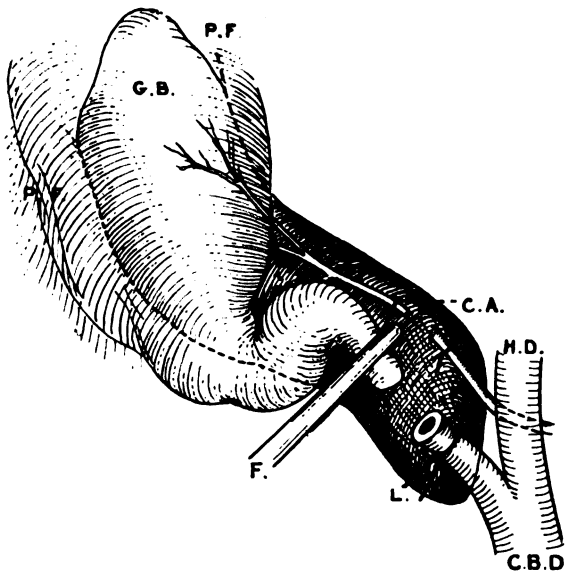

FIG. 46.—CHOLECYSTECTOMY.

The peritoneum (P. F.) is raised in two flaps from the under-surface of the gall-bladder (G. B.). A ligature (L.) has been tied round the cystic duct near its junction with H. D., the hepatic duct. The upper end of the divided cystic duct has been secured before division in a clamp (F.). The cystic artery (C. A.) has been doubly ligatured and divided. The gall-bladder is being peeled off the under-surface of the liver from below upwards. C. B. D., Common bile duct.

impacted at the upper end of the cystic duct, and experience has shown simple removal of the calculus and drainage to be most satisfactory. When the stones are multiple and have caused cholecystitis, there is more reason to fear recurrence of the trouble in after years unless the gall-bladder be excised. Eve (*loc. cit.*) narrates three cases of such recurrence in which he ultimately performed cholecystectomy. It should be remembered that removal of the gall-bladder does not entirely prevent

further formation of calculi, which undoubtedly develop sometimes in the large or small biliary ducts.

The Operation.—The abdomen is opened by a vertical incision through the outer part of the rectus muscle. The gall-bladder is carefully separated from surrounding adhesions until both it and the cystic duct are isolated. The under-surface of the liver is made to project forward both by the presence of the sand-bag behind the patient's back and by the assistant, who draws forward and tilts the liver edge upwards. Gauze pads are inserted as in cholecystotomy. The peritoneum covering the cystic duct is now incised transversely and carefully reflected. The surgeon works round the cystic duct with a blunt dissector in the same way as he would prepare an artery for ligature. In fact, a blunt aneurysm needle may be used to encircle the duct, which is tied with catgut near to its junction with the hepatic duct. A Wells forceps or, if preferred, a small clamp is fixed on the duct nearer the gall-bladder, and the former is divided between the clamp and the ligature. The cystic artery and vein are then cleared and divided between two ligatures. These vessels are usually found with ease, as they lie on the right of and close to the cystic duct. It should be noted that a fair-sized branch of the hepatic artery is often met with to the right of the duct; this occurs in over 30 per cent. (Brewer). If present, this artery should also be secured between two ligatures. (*See* Fig. 46.)

The next step consists in stripping the gall-bladder from below upwards from the under-surface of the liver. This is done mainly by the finger, a flap of peritoneum (which need not be more than an inch wide) being cut on either side with scissors. Owing to the cystic vessels having been already secured there may be little or no bleeding, but as a rule (especially if the gall-bladder is inflamed) there is a certain amount of oozing from the under-surface of the liver. If the gall-bladder is distended and thin, great care should be taken lest it rupture during detachment. When the fundus has been reached the whole viscus is removed, and sponge pressure applied, whilst the surgeon turns

to the ligatured stump of the cystic duct. The closure of this may be made more secure by a second ligature or by a fine silk suture, the peritoneal cuff being sewn over the closed end of the duct. Having made certain that all bleeding has ceased, the surgeon sews the peritoneal flaps together in the site of the removed gall-bladder by a continuous catgut suture. The sand-bag is now removed from under the back, and all "sponges" from the abdomen. A soft rubber drainage tube is inserted well under the liver, the rest of the abdominal wound being firmly closed layer by layer. Many operators leave a plug of gauze in addition to, or in place of, the tube; but this is unnecessary, and the removal of the gauze may prove to be a tiresome and painful performance. Moreover, gauze does not drain well, and we strongly advise against its use where it can be avoided.

The tube is removed within three or four days.

Notes on and Modifications of the Operation. — The separation of the gall-bladder may be performed from the fundus towards the cystic duct, *i.e.* in the reverse direction to that just described. There is no advantage in this, and since the cystic artery is not secured first, there is considerably more trouble as regards hæmorrhage.

Where the gall-bladder has been inflamed and its wall thickened, it will be impossible to dissect off peritoneal flaps as described, nor are they of much importance. If the cystic duct at the point of section has been dilated, it may be safer to close it with a double row of sutures rather than trust to a single encircling ligature, or both sutures and encircling ligature may be employed.

It is obvious that cholecystectomy as described has the advantage of leaving no biliary fistula behind it; on the other hand, it does not allow for drainage of bile, which is indicated in certain cases. The question chiefly arises when suppuration co-exists with the presence of calculi. Supposing there is a calculus tightly wedged in the upper part of the cystic duct, and the gall-bladder is distended with pus, the indication is clear for excision of this viscus, together with the plugged duct,

and no drainage of bile need be aimed at. But if, as Moynihan remarks, "cholangitis be present, as in those cases where a stone is also removed from the common duct or from the ampulla, drainage is certainly necessary." ("Abdominal Surgery," page 546.) Kehr especially has shown how little risk attends the fixation of a rubber tube into the hepatic duct, and complete drainage of bile outside the wound. He is a warm advocate for this course, and reports a series of thirty-three cases so treated without a death.

If the gall-bladder has been excised, the stump of the cystic duct is not ligatured but carefully slit up at its junction with the hepatic duct. A soft rubber tube of suitable size is then insinuated into the latter, the end of the tube projecting upwards within the duct for nearly an inch. As it is inserted the edges of the wound are held with fine tenaculum forceps, and a fine silk or catgut suture passed through both edges and the side of the rubber tube. The suture is tied and the opening made in the duct narrowed round the tube. The other end of the tube (which should be a long one) is then brought outside the abdomen, and when the dressings have been applied it is easy to arrange for all the bile to run into a bottle and to keep the dressings dry. As, however, some leakage may be expected at first, it is well to pack lightly round the tube with some gauze and to insert a second short drainage tube by the side of the main one.

Kehr leaves the gauze tampons in for a fortnight. At least four to six weeks will elapse before the biliary fistula can be closed, and this must be left to nature, as after the main tube has come away the surgeon can do nothing further to close the opening made in the duct. The risk of the fistula becoming very protracted or permanent is probably not inconsiderable, and this, to our minds, constitutes a strong argument why drainage of the hepatic duct should be resorted to as seldom as possible. Kehr's remarkable success, however, deserves emphasis, as there are few surgeons with more experience of difficult gall-stone cases.

CHOLEDOCHOTOMY—INCISION INTO THE COMMON BILE DUCT

After the first introduction of cholecystotomy in 1879 it was not long before surgeons were led to incise the common bile duct in order to remove calculi impacted therein. In 1886 Kehr was able to collect from all sources records of eighty-four such operations, with the grave mortality of nearly 40 per cent. Since then the operation has become a frequent one, with an extensive literature and a diminishing mortality (which may now be put at 10 to 15 per cent.). For some years the removal of calculi impacted at the extreme lower (duodenal) end of the duct presented great difficulty; but in 1893 McBurney proved that such calculi could be reached successfully through the duodenum itself. In 1895 Pozzi and Kocher recorded similar cases, and the number of such operations has become large since then. We have performed transduodenal choledochotomy in four cases, and found it a most satisfactory operation.

Mr. Mayo Robson has published an admirable paper on the surgery of the common bile duct, based on seventeen cases of his own, in the *British Medical Journal*, November 5, 1898. For notes as to the anatomical bearings of these operations see page 144.

When a stone is detected in the common bile duct it is sometimes possible to crush it with protected forceps, but the method is uncertain, involves some injury to the wall of the duct, and allows of no exploration of its lumen. Hence some calculi are apt to be left behind. Calculi, impacted for long, cause such dilatation of the duct that after incision the finger can usually be introduced so as to explore the whole length of the duct upwards and downwards. In fact, as already mentioned, the duct has been met with so dilated as to resemble the small intestine. Mayo Robson advocates dilatation with the finger in all cases where it is practicable, "reserving a bent probe or, better still, a slender bent scoop for use where the duct is not capacious enough for the finger. The hepatic duct and its primary branches

can be readily explored, and I have removed calculi from them through an incision in the common duct" (Mayo Robson, *Brit. Med. Journ.*, Nov. 5th, 1898). The bent scoop should be made of flexible metal throughout.

The Operation.—The preparation of the patient, the instruments, and the preliminary incision, etc., are the same as for cholecystotomy (page 146). It is essential to have a firm sand-bag behind the patient's loins, and after the abdomen is opened the assistant should draw the liver and costal edge well upwards so as to expose and straighten out the biliary ducts. A vertical incision of the abdominal wall through the semilunar line or right rectus muscle is usually employed, to which it is easy to add a short transverse one. Some surgeons advocate a nearly transverse incision reaching towards the lumbar region. Such a cut is somewhat more liable to be followed by a ventral hernia.

Adhesions of the gall-bladder and liver to the stomach or duodenum, if present, must be carefully separated, and the gall-bladder is drawn upwards with the liver. If the gall-bladder is felt to contain calculi it is opened and the latter are evacuated. After the fluid has been let out the opening should be guarded by sponges or gauze held in place by an assistant whilst the operator traces down the cystic and common bile ducts. With finger and thumb he ascertains the position and number of calculi present in the common duct. A frequent place for impaction in the duct is just above the orifice into the duodenum, where the duct is somewhat dilated (forming the ampulla of Vater). It will be remembered that the duodenal orifice is the narrowest part of the duct, and that it is situated at the inner and posterior aspect of the duodenum, just at the angle between the second and third parts of the bowel. Besides the ampulla of Vater there may be another dilated portion of the common duct in which calculi are apt to lodge, immediately below the junction of the cystic and hepatic ducts. In tracing down the common bile duct in its lower half some assistance will be obtained by slightly detaching and depressing the duo-

denum. The greatest care is necessary in doing this, owing to the close relation of the portal vein (behind the duct) and the hepatic artery to its left. As already noted, a branch of the hepatic artery is found to the right of the common or cystic duct in 30 per cent. of cases. The pancreatico-duodenal artery (a branch of the hepatic) may give trouble. The lowest inch or more of the duct is quite inaccessible from above, and can only be reached through the duodenum (*see* Fig. 43, page 145).

In most cases of impacted calculi, however, the stones can be reached through an incision made in the axis of the duct where it lies between the layers of the gastro-hepatic omentum, *i.e.* above the duodenum. The incision is usually made directly over the calculus, the duct being steadied and held forwards with the left hand ; the incision should be long enough to admit the index finger. The calculi are then extracted with a scoop, care being taken lest the rush of bile should soil the peritoneal cavity. The index finger is, if possible, introduced through the wound in the duct, and exploration made for any other stone.

The most difficult step of the operation is now to be carried out, that of suturing the small wound in the duct. Fine silk (No. 1) on a curved needle in a needle-holder is employed, but the thinness of the duct may possibly prevent the wound from being perfectly closed, and it is essential, therefore, to provide for subsequent leakage. The suture should traverse only the outer layers of the duct wall if possible, avoiding the mucous lining. It is held that a suture in the mucous membrane may favour calculous deposit, and actual cases have been reported where this seems to have occurred. A special form of needle-holder (such as Halsted's with Rampley's grip, shown in Fig. 47) is useful. Small metal hammers have been devised by Halsted for the purpose of introduction into the duct to facilitate suture, but no advantage whatever attends their use. After careful cleansing of the operation area and removal of all sponges, drainage is provided for by a rubber tube, one end of which is placed opposite the sutured duct ; the tube is then lightly packed round with gauze, which is brought out of the wound in the

abdominal wall at its lowest point. Some surgeons dispense with the tube, using only the gauze drain. The greater part of the abdominal wound is then closed with silkworm-gut sutures.

It will be understood from the above description that accurate closure of the wound made into the common duct may be fairly easy in some cases, difficult or impossible in others. As Langenbüch pointed out, the duct may be made more accessible if one or two fingers are introduced into the foramen of Winslow and made to push the gastro-hepatic omentum forwards. Of course,

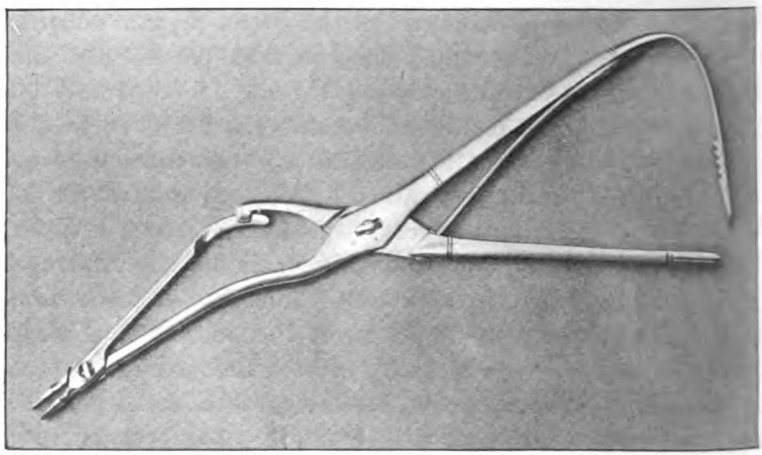

FIG. 47.—HALSTED'S NEEDLE-HOLDER WITH RAMPLEY'S JAWS FOR CURVED NEEDLES ADAPTED FOR DEEP SUTURING WITHIN THE ABDOMEN.

the greatest care must be taken in making the incision to open the duct alone, as the portal vein lies so close to it. Fortunately the impacted calculus affords in practically every case the guide for the incision.

There is a curious difference of opinion amongst surgeons as to whether the choledochotomy wound should be sutured or not. For instance, Quénu, Moynihan, Schwartz, Renton have pronounced in favour of drainage alone, and Hartmann goes so far as to denounce suturing as "always unnecessary and sometimes harmful." On the other hand Mayo Robson, Michaux and others have recorded excellent results from suturing, and

Kocher declares that " choledochotomy should only be employed in those cases where exactitude in the insertion of the sutures can be relied on " (" Operative Surgery," Stiles's translation, 1903, page 229).

On this question, as on most others relating to surgical procedure, dogmatism is probably unwise.

A careful attempt should be made in most cases to suture the duct-wound, but where the difficulties are obviously very great, drainage alone should be trusted to. A tube should then be inserted exactly in the manner described on page 160. As already noted, the surgeon should first ascertain by means of his finger in the duct that no other calculi are left behind. In any case, whether sutures have been used or not, additional precautions are taken for drainage of the operation area after it has been cleansed and before the abdominal wound is sewn up.

RETRODUODENAL CHOLEDOCHOTOMY

The second portion of the common bile duct lies behind the first part of the duodenum, more or less embedded in the pancreas. It can be approached from behind after the peritoneum outside the duodenum has been incised, and the latter pushed forwards with the finger. Calculi have been removed by this route, but the cases for which it would be advisable are singularly few. Damage to the pancreas, leakage of bile into the subperitoneal tissues, troublesome hæmorrhage, are three dangers of this method. Moreover, should calculi lodge in this portion of the duct they can be reached by forceps or a scoop from above, or can be pushed upwards by manipulation with the fingers.

A calculus is more often impacted in the ampulla than in the second part of the duct. Fig. 43 shows such a case, and the relation of the papilla to the fold of duodenal mucous membrane above it. In this position the best operation is certainly to approach the duct through the second part of the duodenum, as first suggested and carried out by McBurney of New York in 1891.

TRANSDUODENAL CHOLEDOCHOTOMY

If, after opening the abdomen for biliary obstruction, the surgeon finds a firm lump to the inner side and posterior aspect of the vertical part of the duodenum, it is almost certainly due to one large stone in the ampulla or to a collection of smaller

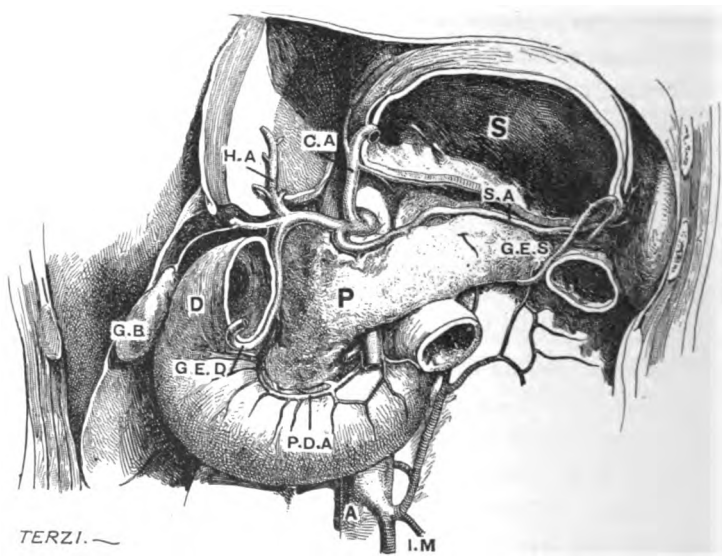

FIG. 48.—ARTERIAL SUPPLY OF STOMACH AND DUODENUM, ETC. (*After Testut.*)

The site of incision for transduodenal choledochotomy is where the letters G. E. D. (gastro-epiploica dextra artery) are placed on the duodenum. The incision through the duodenal wall should, however, be vertical in the axis of the bowel. P. D. A., the pancreatico-duodenal arteries, which form an arch in the hollow of the duodenum, may cause bleeding in this operation. S, Stomach, cut across; P, Pancreas; D, Duodenum; A, Aorta; G. B., Gall-bladder; H. A., Hepatic artery; C. A., Coronary artery of stomach; S. A., Splenic artery; G. E. S., Gastro-epiploica sinistra artery; I. M., Inferior mesenteric.

ones. Induration of the pancreas may simulate a stone, but in that case the hardness is usually more diffuse.

To reach calculi in the ampulla an incision one to two inches long is made through the front of the vertical part of the duodenum. Gauze-pads should be placed around and below the duodenum before the intestine is opened, and small sponges on holders should at once be inserted to cleanse the inte-

tine. It is, however, noteworthy that, as a rule, the latter will be found almost dry and clean. Through each edge of the intestinal wound a suture is passed as a retractor, the assistant holding these apart. The surgeon feels with his finger for the calculus. This will probably bulge the mucous membrane forward over it, or it may even project slightly through the actual orifice of the duct. It is in either case easy to enlarge the orifice with scissors or bistoury, and to extract the stone with a small scoop. Care should be taken to ascertain that the duct above is quite clear. Of this a gush of bile into the intestine after the stone is removed is a good sign.

Supposing that the calculus is fixed in the duct an inch or so above the ampulla (*e.g.* at B in Fig. 43), an attempt should be made to extract it with forceps or scoop from below, after enlarging the ampullary opening. If this fail, the intestinal wall must be incised directly over the stone, and then the wall of the duct. This double opening carries with it the risk of extravasation of bile into the tissues of and around the pancreas ; hence it should be avoided if possible. If it be unavoidable, a careful attempt should be made, after extracting the stone, to sew the wall of the duct on either side to that of the intestine, so as to establish a fistula between the two just above their normal communication, and thus to prevent extravasation.

Troublesome bleeding from the pancreatico-duodenal vessels may occur during the high operation just described (*see* Fig. 48).

The main anterior incision in the duodenum is now accurately closed by a double row of fine silk sutures, the first including only the mucous membrane, the second the outer coats. There will be no special need for drainage if this suturing be carefully done.

Rectal feeding is advisable for a few days.

CHOLECYSTENTEROSTOMY

By this term is understood the establishment of a fistula between the gall-bladder and the intestine. The not less uncouth, but less precise, term of entero-cholecystotomy has also been applied to this operation.

The procedure has been carried out in cases in which there is an insuperable obstruction in the common bile duct, such as may have been brought about by destructive inflammatory changes, or be due to the pressure upon the duct of a malignant tumour. Mr. Mayo Robson has carried out the operation with success in the treatment of a biliary fistula, through which, apparently, the whole of the bile was discharged.

The operation of cholecystenterostomy appears to have been first suggested by Nussbaum. The first actual operation was, however, performed by Winiwarter (*Prag. Med. Wock.*, No. 21, 1882).

The Operation.—The operation has been performed in many ways, and no settled practice can be said to be established. It would seem best theoretically to unite the gall-bladder to the duodenum, but it is, as a rule, easier and safer to make the opening into a coil of the jejunum (Kocher).

Sometimes the anastomosis has been made with the colon, but this is objectionable in more than one aspect, and should be resorted to only if the other courses seem impracticable.

The method used may consist in suturing alone, or in the use of the smallest size of Murphy's button. It is probably the only form of intestinal anastomosis in which the use of the latter will survive. The operation is, however, very rarely indicated, and the conditions under which it is practised (from adhesions around the parts, etc.) are such that simple suturing may prove very tedious and difficult. Murphy's button shortens the proceedings, but even the use of this may tax the surgeon's skill and patience considerably.

The operation has been done in two or even three stages, but undoubtedly it is best to complete it in one.

The proceeding resembles so closely gastro-jejunostomy that no full description is called for. The chief difficulty in performing the operation is, perhaps, the prevention of the escape of bile into the peritoneal cavity. Hence the space around the gall-bladder should be packed with sponges before incising that viscus, and the orifice of the button should be plugged

with cotton-wool pledgets until the surgeon is ready to press the two halves together, when of course the plugs should be removed. With good assistance the extravasation of bile can usually be prevented.

The heavier half of the button should be placed in the intestine, the lighter in the gall-bladder. If possible, some fine silk sutures should be inserted around the area of union so as to guard against extravasation. Further, when sewing up the abdominal wound, provision by tube or gauze should be made for drainage. In not a few cases of cholecystenterostomy leakage of bile or intestinal contents through the abdominal wound has occurred for a time.

When the colon has been opened in making the anastomosis this is especially likely to occur, or fæcal stuff may escape into the gall-bladder, causing septic cholangitis.

But, whatever method be adopted, cholecystenterostomy is never an easy operation, nor one that is certain to relieve. Fortunately its place can now be taken, as a rule, by cholecystectomy or some other procedure.

NOTE ON THE GENERAL SUBJECT OF OPERATIONS ON THE GALL-BLADDER AND BILIARY DUCTS

From the preceding review the reader will infer that such operations may be the simplest or the most complex in the whole range of abdominal surgery. Leaving apart biliary obstruction from malignant tumours, for which practically nothing can be done, they are amongst the most successful and satisfactory.

The surgeon must be prepared to carry out any one of the various operations described; he must endeavour to make certain that all the calculi causing obstruction are removed; he must expect (especially in all septic or complicated cases) that there will be considerable shock and pain following the operation.

Troublesome sickness for a day or two is very common. Hence nothing but small quantities of warm water should be

given by the mouth for twenty-four hours; a hypodermic injection of morphia and strychnia may be advisable the evening after the operation, with rectal feeding for a couple of days.

Saline injection (two pints) per rectum with an ounce or two of brandy should be administered, where shock is expected, before the patient comes round.

There is no doubt that in a good many cases a slight attack of peritonitis occurs after these operations, and is recovered from. Morphia and strychnia combined will be very useful.

CHAPTER III

OPERATIONS ON THE STOMACH

Anatomical Points.—The position of the stomach, and its relations to surrounding parts, are much influenced by the degree of distension which it exhibits, and are further apt to be modified by the effects of disease, either in its own walls or in the structures which surround it.

When empty, the stomach lies at the back of the abdomen, beneath the liver, and some little way from the surface. When distended, the greater curvature is elevated and carried forwards, the anterior surface is turned upwards, and the posterior downwards. The direction of the rotation depends mainly upon the fixity of the smaller curvature.

Normally, the lesser curvature looks upwards, backwards, and to the right (*see* Fig. 49). When distended, the anterior surface is brought well against the anterior belly wall, and the viscus may occupy the whole of the median line as far as the navel. In obstruction of the pylorus the dilated stomach may nearly fill the abdomen, and its greater curvature may reach to the groin.

Under normal conditions, the *cardiac orifice* is situate behind the seventh left costal cartilage, about one inch from the sternum. It is placed deep in the abdomen, about one inch from the left side of the tenth or eleventh dorsal vertebra, separated from it by the aorta. The *pylorus*, when the viscus is empty, lies just to the right of the middle line, from two to three inches below the sterno-xiphoid articulation. The position and anterior relations of the stomach are shown in Fig. 37, page 125. The pylorus is not usually in contact with the anterior abdominal wall, being

separated from it by the lower edge of the liver. When distended, the pylorus may be moved nearly three inches to the right of its usual position, and it may sometimes be displaced downwards to a remarkable extent. In one case of pyloric cancer with great distension of the stomach, in performing

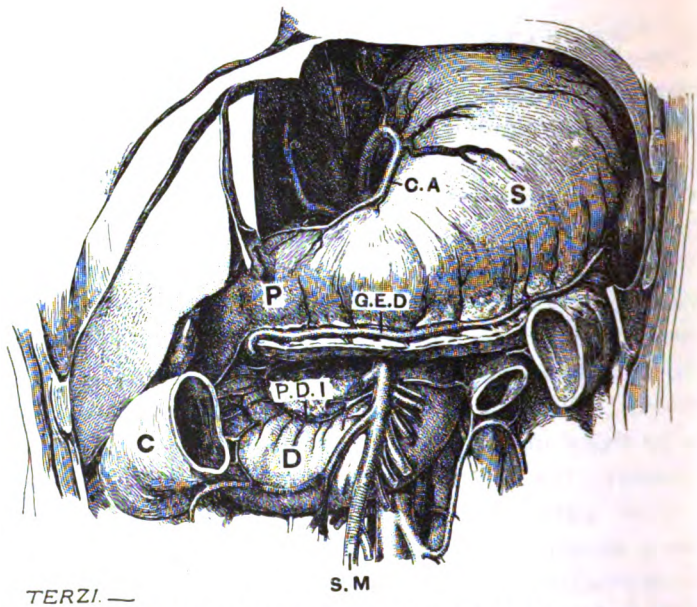

FIG. 49.—POSITION AND RELATIONS OF THE STOMACH AND DUODENUM, SHOWING ALSO THEIR ARTERIAL SUPPLY. (*After Testut.*)

S, Stomach; P, Pylorus; D, Third part of duodenum; C, Hepatic flexure of colon (note the transverse colon is cut away); C. A., The coronary artery; G. E. D., Right gastro-epiploic artery running in the great omentum; S. M., Superior mesenteric artery, with its inferior pancreatico-duodenal branch (P. D. I.).

gastro-jejunostomy we found the pylorus close to the right anterior superior iliac spine!

The *fundus* of the stomach reaches on the left side to a point as high as the level of the sixth chondro-sternal articulation, and is directly in contact with the diaphragm (Fig. 49).

The *uncovered area of the stomach* is normally represented by a triangle, the right side of which is formed by the edge of the liver, the left side by the borders of the eighth and ninth

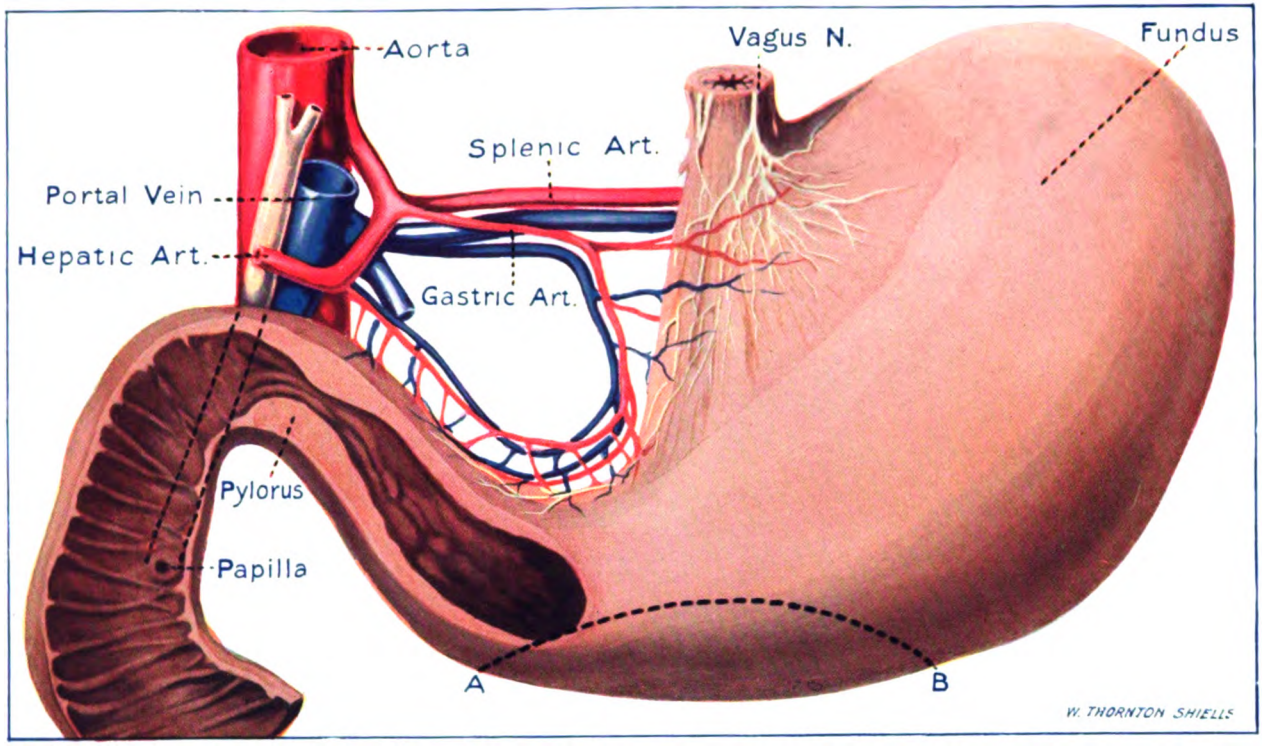

PLATE X.—STOMACH AND DUODENUM, SHOWING THE GASTRIC OR CORONARY ARTERY, ETC.

(From a Dissection in the Museum of the Royal College of Surgeons.)

THE AREA CIRCUMSCRIBED BY THE DOTTED LINE ON THE LOWER PART OF THE STOMACH INDICATES THE POSITION CHOSEN FOR GASTRO-JEJUNOSTOMY.

costal cartilages, and the base by a horizontal line drawn between the tips of the tenth costal cartilages (Fig. 50).

The tip of *the cartilage of the tenth rib* is an important landmark, and it is one not difficult to recognise. Tillaux points out that this cartilage has a distinct tip, that it is attached to the ninth cartilage by a ligament some six or seven mm. in width, that it plays over the latter cartilage, and produces under the finger a special crepitus (*bruit*). (*See* Fig. 50.)

The position of the *lower edge of the liver* in the left subcostal angle is liable to variation, but under normal conditions it may be represented by a line drawn from the ninth right cartilage to the tip of the eighth left cartilage.

The *pyloric opening* is small, and has an average diameter of 16 mm. This about corresponds to the diameter of a sixpenny-piece.

The arterial and lymphatic supply of the stomach is of special interest in regard to excision of tumours of that organ (*see* Figs. 49 and 56, pages 172 and 195). The coronary or gastric artery from the cœliac axis reaches the stomach close to the œsophageal opening (Plate X.), it then runs along the lesser curvature from left to right, supplying both surfaces of the stomach wall, to join with the small pyloric branch of the hepatic artery. A chain of lymphatic glands along the coronary vessels is always involved in extensive cancer of the stomach. The great curvature and lower part of the organ are supplied by the anastomosing gastro-epiploic arteries from the hepatic and splenic vessels. The lymphatics from the left lower part of the stomach pass up to the splenic and aortic glands; those from the right lower half run downwards to the subpyloric glands (*see* Fig. 56), a scattered group numbering three to six. For practical purposes the surgeon in undertaking resection of part of the stomach will have to secure one artery and vein on either side both above and below; and, as regards secondary deposits of growth in the lymphatic glands, those along the lesser curvature and the subpyloric group are all-important. This question is further discussed on page 194, and in Delamere's work on the

Lymphatics (C. H. Leaf's translation, 1903) fuller details will be found.

The following operations upon the stomach will be described :—

1. Gastrostomy.
2. Gastrotomy.
3. Operations for Hour-Glass Stomach.
4. Pyloro-plasty.
5. Resection of the Pylorus.
6. Gastro-jejunostomy.
7. Operations for Ulcer of the Stomach.

I. GASTROSTOMY

This operation consists in establishing an artificial opening (*stoma*) in the stomach, through the parietes, with the purpose that the patient may be fed through the new "mouth."

Gastrostomy is carried out in cases of obstruction of the gullet, especially in such as are due to malignant disease.

History of the Operation.—In 1837, Egebert, a Norwegian surgeon, advocated this measure in cases of stricture of the œsophagus which were beyond local treatment. He described the details of the operation with great minuteness.

A little later, Blondlot demonstrated the practicability of forming gastric fistulæ in animals.

In 1849, Sédillot performed the first operation upon the human subject. The patient died. The same result followed in a second and a third case. Fenger carried out the operation in 1853. This patient also died. In 1858, Mr. Cooper Forster, of Guy's Hospital, performed the first gastrostomy in England, but with a fatal result. The operation was attempted by Günther, Gross, Curling, Bryant, and others, but in each case death ensued. The first satisfactory result was obtained in 1874 by Mr. Sydney Jones.

The practice of delaying the opening of the stomach was advised by both Egebert and Nélaton.

It should be noted, however, that the patient, if suffering from malignant disease of the œsophagus, is probably so near starvation at the time of operation that it is necessary to complete the operation

and feed him on the same day. With modern methods there is no reason for dividing the operation into two stages.

Recent modifications, all having as their object the formation of an oblique or valvular opening instead of a direct one, have been brought forward by Witzel, Kader, Frank, and others. They will be noted later.

Preparation of the Patient.—If the patient is no longer able to swallow, his strength should be supported by nutrient enemata. One such injection, containing an ounce of brandy, may be given just before the operation. There is no need to adopt any special means for distending the stomach. The body should be well covered up with blankets, and the limbs surrounded by hot-water bottles.

Deep anæsthesia is not required. We have performed the operation when so small an amount of ether has been given that the patient, while complaining of no pain, has yet been dimly conscious of all the steps of the operation. It may be performed under eucaine or cocaine injections (2 per cent. solution of either). The quicker the operation can be carried out, within reason, the better. The usual antiseptic preparation of the abdominal wall is made beforehand. As regards the position of the patient, he should be recumbent and close to the left side of the table. A sand-bag should be placed across the table so as to raise his epigastrium.

The surgeon stands to the left of the patient, and the chief assistant to the right.

Instruments Required.—Scalpels; blunt-pointed bistoury; dissecting forceps; pressure forceps; scissors; metal retractors; blunt hooks; curved needles and needle-holder; sutures; ligatures, etc.; sharp tenotome to open the stomach; rubber tube or catheter of about No. 10 English size.

(1) **The Parietal Incision** (Fig. 50).—The surgeon should endeavour to mark out the lower edge of the liver by percussion and palpation. The normal position of this edge has already been given (page 173). The liver, however, in the operation area

may be found as high up as the level of the xiphoid cartilage, or as low down as the level of the ninth costal cartilage. In cases of stricture of the gullet the organ is usually a little lower than normal, owing to the empty condition of the stomach and intestines.

The incision is oblique, is parallel to the margin of the left costal cartilages, and about one inch from that margin. Its length is about two inches, and may be modified according to the thickness of the parietes. The shorter the incision, within reason, the better. If there is unusual difficulty in finding and drawing out the stomach, the wound may then be enlarged.

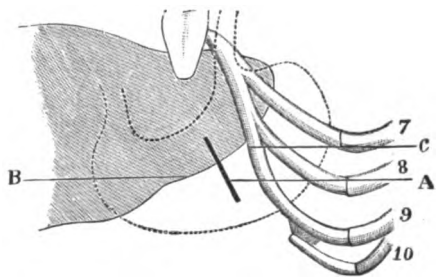

FIG. 50.—GASTROSTOMY.

A, Incision; B, Margin of the liver; *c*, Margin of the costal cartilages; 7, 8, 9, and 10, Seventh to tenth costal cartilages.

The centre of the incision should correspond to a point from three-fourths of an inch to one inch below the margin of the liver (Fig. 50).

If the cut be too near to the ribs, the wound is apt to be needlessly disturbed by the movements of the thorax, and but little tissue is left on the outer margin of the wound to give a hold to the sutures. The edge of the cartilages comes also in the surgeon's way.

If the cut be too low down, the stomach is missed, or undue traction is made upon its walls. If it be too high up, the liver comes in the way; and although the stomach may be dragged up from beneath the liver, yet the sharp margin of that organ is apt to bear with injurious pressure upon the line of sutures which unite the stomach to the parietes.

The incision is carried through the tissues of the abdominal wall. The fibres of the external oblique muscle will be found to run almost at right angles to the line of the wound, and the fibres of the internal oblique to be nearly parallel with that

line. The transversalis muscle will be cut transversely. The incision will probably cross the left semilunar line, in which case some fibres of the rectus are exposed.

The peritoneum is reached, and is divided to the full length of the original wound.

Modifications of the incision are described in the Comment upon the operation.

(2) **Exposure of the Stomach.**—Retractors are introduced into the wound, and search is made for the stomach. The liver will come into view, and below the margin of that organ the stomach may at once be detected. It is recognised by the smoothness and absolute opacity of its surface, by its faint pink colour, and by the thickness and stiffness of its wall, as demonstrated by pinching up a fold between the thumb and finger. To make the identification more certain, the relations of the viscus to adjacent structures, and especially to the liver, should be made out.

The colon has been mistaken for the stomach, and has been opened under the influence of that error. The stomach is usually contracted, and lies high up, under cover of the left lobe of the liver. In such case, the omentum or the transverse colon commonly presents. By means of a gauze sponge held in long pressure forceps, the colon may be thrust downwards into the abdomen, and the stomach thus brought into view; or the surgeon may draw the colon downwards with his fingers. The omentum is more conveniently pushed away by means of the sponge, to the surface of which it readily attaches itself.

In any case of doubt the surgeon should follow the under-surface of the liver with his finger as far as the portal fissure. Thence he is conducted to the stomach by the gastro-hepatic omentum.

The stomach should be drawn to the wound, and the spot at which to open it must be determined upon.

This spot should be as near the lesser curvature as possible, and at a part free from large veins. It is most important,

however, that the new opening should be so placed as to avoid any traction upon the stomach.

As soon as the situation of the "stoma" has been determined upon, the stomach wall may be lightly seized at the centre of the selected area with pressure forceps. By means of these forceps an elongated pouch of the organ is drawn forwards and held in position while the sutures are being introduced.

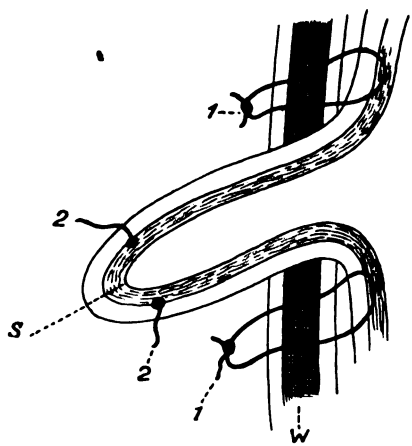

FIG. 51.—GASTROSTOMY.

A pouch of stomach (S) is drawn out and fixed by sutures, two of which (1 and 1) are shown passing through the abdominal wall (W). These, although shown loose, are securely knotted A continuous suture (2 and 2) is passed through the outer coats of the stomach-pouch, which is then incised at S.

(3) **Fixing of the Stomach.**—This is best effected by means of fine silkworm-gut or silk sutures. The needles should be of moderate size (about No. 5), and fully curved.

The stomach is drawn well forward into the wound and each needle is made to take a good hold of the gastric wall. It should penetrate all the coats except the mucous. The needle is then carried through the peritoneum, and ultimately through the muscular layers of the parietes and the skin. In order to make the inclusion of the peritoneum simple and certain, it is as well to fix it on either side with pressure forceps, by means of which the membrane can be brought well into view while the needles are being passed.

The sutures should be so inserted as to circumscribe an area on the stomach about equal to a shilling-piece. From six to ten sutures will suffice. It is as well to introduce several of the main sutures before any are tied. The sutures should take up enough of the stomach wall to secure a good hold. The mucous coat must not be punctured, and each stitch must be very securely

tied. There should be no dragging upon any part of the stomach. The sutures fix the base of the tubular pouch, which is drawn out into the wound. (Figs. 51 and 52.)

(4) **Opening of the Stomach.**—It is usually well to open the stomach at once in order to feed the patient. Should, however, the condition of the patient be sufficiently good to warrant three or four days' delay, the surgeon may decide to defer the opening for this time. There can be no doubt that this delay, made from a somewhat needless dread of causing peritonitis, has frequently caused death from exhaustion. Immediate opening according to the plan described is perfectly safe, and is to be advised. The essential thing is to make the incision through the stomach wall small and valvular. A great variety of methods have been devised with this object, but the following will be found as good as any. (*See* Figs. 51 and 52.)

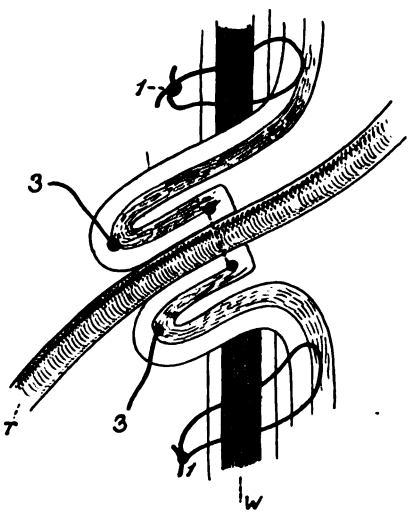

FIG. 52.—GASTROSTOMY.

The rubber tube (T) is introduced and fixed by tightening the suture shown in the previous figure. The pouch is then invaginated and a second continuous suture (3 and 3) maintains this condition.

NOTE.—The sutures 1 and 1, in both figures, should be tied more tightly.

A continuous silk suture is made to circumscribe a small circular area at the apex of the pouch, passing through the outer coats; before it is tied the stomach wall is incised with a tenotome within this area so as just to admit a No. 10 English rubber catheter, a few inches of which are passed into the cavity. The stitch is then tied so as to fix the catheter without constricting its lumen, and the pouch invaginated for half an inch or so. A second continuous suture (passed into the rubber) is then introduced, as shown in Fig. 52, which prevents the

tube from slipping and maintains a valvular fold of the whole stomach wall. The rubber tube can be attached when required to a glass funnel. Feeding with small quantities of milk, strong beef-tea, etc., is begun with caution as soon after the operation as is thought advisable, the tube remaining in for several days, and being subsequently introduced from time to time.

If care be observed, there is practically no risk of any extravasation taking place during the feeding; and even if it be assumed that the peritoneal cavity is not securely sealed, there is still no difficulty in preventing such an accident.

If it be determined to effect an opening into the stomach within a few hours of the first operation, the mode of suturing above described will be found to suffice. The attachment of the viscus to the parietes may in such case be rendered doubly secure by a series of fine silk sutures which are interposed between the main stitches, and which concern only the parietal peritoneum and the outer coats of the stomach.

The actual opening of the stomach is a very simple matter. It is painless, and no anæsthetic is required. Indeed, if the condition of the patient does not warrant a general anæsthetic being given, all the steps of the operation may be carried out under eucaine.

(5) **Feeding of the Patient, and After-treatment.**—The amount of food introduced on the occasion when the stomach is opened must depend upon the patient's condition. If no food has been swallowed for a considerable period, it will suffice at first to introduce only a few drachms of milk mixed with a little brandy. The quantity can be gradually increased. If, however, the patient has been able to take some food through the gullet up to the time of the operation, his first meal may consist of from two to four ounces of a mixture of milk, egg and brandy. This is slowly poured in through the funnel, the gauze covering of which prevents any semi-solid particles from entering and blocking the tube. A pad of soft gauze packed around the aperture in the stomach will absorb any fluid which

may escape. As a matter of fact, however, such escape is very seldom to be anticipated.

After the feeding the tube is left in place. A small clamp is fixed to it, and the tube itself may be retained in place by a long strip of Meade's strapping applied to the chest wall. A dressing of sterile gauze and wool is bandaged over the small wound. To avoid the discomfort of changing this dressing every time the patient is fed it is well to arrange the gauze carefully around the rubber tube so as to keep the latter in place without obstructing it.

The feeding should be repeated frequently, and the amount given slowly increased, but the quantity administered each time should be small.

The diet will consist of milk, eggs, beef-tea, soups, tea, cocoa, certain prepared foods, and a proper allowance of water.

All food administered should be of the temperature of the body. As time advances, more food may be given, but at less frequent intervals. The fistula may in process of time become enlarged, and then very finely-minced meat and pulped vegetables may be introduced into the stomach by means of a suitable syringe. On the other hand, a tendency to contract is sometimes shown, and must be overcome by occasional dilatation with a seatangle tent.

The patient's own feelings afford the best guide to the value of certain foods and the amount and mode of their administration. When the gastrostomy opening has been made a valvular one after the manner described above, there is rarely any after-trouble from leakage of gastric juice or regurgitation of food, but these sequelæ may sometimes occur owing to the stomach having been opened too near to the pylorus. The patient who is the subject of such trouble should be fed in the recumbent position, and lying upon the left side. Leakage may also be due to the gastric opening having been made too large.

The irritation produced by the escape of gastric juice is best met by constant attention to cleanliness, by the very

frequent changing of dry absorbent pads, and by the liberal powdering of the part with bicarbonate of soda.

Comment.—Many forms of incision have been advised and carried out. Some have employed an incision in the median line, others a vertical incision in the left linea semilunaris. Sédillot used a cross cut below the xiphoid cartilage. Howse advocated a vertical incision in the sheath of the rectus, a little to the inner side of its outer border. The vertical fibres of the rectus are exposed and are separated (not cut) with the handle of the scalpel. The posterior part of the sheath is thus reached. It is divided vertically, and the abdominal cavity opened.

The incision has the disadvantage of bringing the wound area somewhat closer to the pyloric region.

In carrying out the incision advised in the text, it should be remembered that, owing to the emaciation of the patient and the sunken condition of the abdomen, the part of the belly wall attacked is—as the patient lies upon the back—almost vertical. The integument, after passing over the margin of the ribs, turns suddenly backwards towards the spine, following the sunken abdominal wall.

There is no advantage attending the practice of stitching the divided edges of the peritoneum to the margins of the skin wound before the wall of the stomach is secured in place.

Frank's Method.—A conical tube of stomach wall is drawn upwards and its base secured to the parietes in the manner already described (page 178). The tubular portion rests on the rib cartilages, its extreme apex is then opened and fixed to the skin, a rubber tube being inserted. The skin and fascia are sewn over the conical projection. It will be understood that no invagination of the stomach wall is employed.

Kocher has modified Frank's method in the following respect: After the pouch of stomach has been drawn forward and secured by sutures at its base, "a narrow drainage tube is now laid vertically on the anterior surface of the stomach wall" (*i.e.* the tubular process), "and the latter is stitched over it for half an inch by means of a continuous suture, applied in

such a way as to include the serosa and a layer of the muscular coat on either side of the tube. Just below the suture a small opening is made into the stomach, three to four inches of the tube is passed into it, and the serous coat is stitched over the part of the tube which is left exposed as it passes through the aperture in the stomach. The stomach, all round the spot where the tube comes out of its tunnel, is now securely sutured to the skin. The edges of the wound are then stitched together over the stomach protuberance, and a short glass drain is put in above and below, under the sutured skin wound." We see no reason to prefer this or Frank's method to the valvular one described on page 179, which Kocher admits is more simple and gives excellent results.

The many different methods adopted of feeding the patient only serve to emphasise the fact that no rigid rule can be adhered to, and that this factor in the after-treatment must be modified according to the particular circumstances of each case.

Results of the Operation.—Gastrostomy cannot be said to occupy a very exalted or favoured position among surgical measures. It belongs to the forlorn category of last resources. It is for the most part carried out in patients who are dying of cancer, and whose death is being hastened by starvation.

One thing is certain, and that is—the operation is usually carried out too late. The condition of malnutrition into which the patient is allowed to sink is eminently favourable to the growth and progress of a cancerous mass. The stomach is allowed to pass into a state of atony before any attempt is made to introduce food into it.

The operation often gives great comfort to the patient, and relieves him of the distress attendant upon feeding by an œsophageal tube. Three to six months' relief is usually the most to be hoped for. In one case, however, of my own (F. T.), life was prolonged by the operation for almost three years (*Brit. Med. Journ.*, June 20th, 1903). A patient of R. Morison's survived the operation 407 days, during six months of which he was able to work as a tailor (R. Morison, *Brit. Med. Journ.*, May 7th, 1892).

The troubles arising from the establishment of the fistula—the acute gastritis, the prolapse of the stomach wall, the inflammation of the skin caused by the escape of gastric juice—which were reported in connection with the early operations are all to a great extent preventable, and these after-evils have practically vanished as the *technique* of the operation and the management of the case have been improved.

The most elaborate statistics of the operation are those collected by Gross (207 cases) and by Zesas (162 cases). Gross gives a mortality of 30 per cent., and reckons that life is prolonged for an average period of eighty-two days in the cases of malignant disease.

The mortality of the operation in cases of cicatricial stricture was about the same, and the average duration of life after the stomach was opened was 295 days.

Zesas finds that the mortality of the operation (since the introduction of antiseptics) is as high as 70 per cent. It is evident that he adopts a method of distinguishing between death from the operation and death from the disease different from that adopted by Gross. The periods of dying are divided as follows: Under 24 hours, 17 cases; under 30 hours, 69; between 1 and 12 months, 19; between 12 and 18 months, 1. The majority of the deaths are due to exhaustion, pneumonia, or peritonitis.

2. GASTROTOMY

This term is applied to the operation of opening the stomach for the purpose of removing a foreign body, or for exploration.

The cutting into the stomach for the removal of a foreign body is an operation of some antiquity.

"A surgeon and lithotomist named Shoval" removed a knife-handle measuring six and a half inches in length from the stomach of a young peasant on July 9th, 1635. No sutures were applied to the stomach, and five only to the external or parietal wound. The part was dressed with "tepid balsam, bolar earth, white of egg, and

alum." The patient completely recovered (South's edition of Chelius, vol. ii., page 391).

Many successful cases have been reported from time to time since that date.

The foreign bodies removed have included forks, knife-handles, spoons, plates of false teeth, and masses of hair.

The anatomical relations of the parts concerned have been already dealt with. The preparation of the patient, and the instruments required, are considered in the section on Gastrostomy.

There is no need to attempt to bring about an artificial distension of the stomach before the operation.

The Operation.—The parietal incision may be made in the same position as is advised in gastrostomy, with this modification —that it may be conveniently placed a little less close to the margins of the ribs.

If the foreign body can be distinctly felt through the parietes, then the incision may be made directly over it. The cut has been made in the left semilunar line. In removing unusually large foreign bodies, such as are represented by masses of hair, the incision may be conveniently made in the median line. The exact position of any metallic body can be ascertained beforehand by radiography.

The incision should be at first about two and a half inches in length. It may be enlarged subsequently as required.

The peritoneum is divided and the stomach sought for. If the contained foreign body be sharp-pointed, the manipulation of the stomach must be conducted with great care.

When the surgeon has determined upon the spot at which the opening into the stomach is to be made, two silkworm-gut sutures may be passed through the serous and muscular coats of the viscus, one on either side of the area selected for the incision. These sutures are allowed to form long loops, by means of which the stomach can be drawn forwards and held in place.

The stomach wall should be gently drawn well into the parietal wound, and before the opening is made the space

between the viscus and the margins of the parietal incision must be plugged with sterilised gauze.

The incision into the stomach should be transverse to the long axis of the viscus, *i.e.* in the line of the blood-vessels.

As soon as the organ has been opened, the forefinger is introduced, and the position of the foreign body made out.

It should be so manipulated as to place it in the position best suited for ready removal.

Forceps will probably be required to effect the extraction. Care must be taken not to damage the wall of the stomach by careless manipulation, or by attempts to drag the foreign body through too small an incision.

The next step is the closure of the wound by suture. Fine silk should be used for the purpose. The divided mucous membrane is first of all brought together by means of a continuous suture. This is best introduced by a small fully-curved needle held in a needle-holder. The sutures must be well secured at each end, and must be tightly drawn throughout. The laxity of the gastric mucous membrane renders the application of this suture an easy matter.

The outer part of the gastric wound is closed by many points of Lembert's sutures. These are of fine silk, are introduced by means of an ordinary milliner's needle or a circular needle, and include both the serous and the muscular coats. A continuous suture may be employed instead of the interrupted one.

Any of the methods employed for suturing the intestine may be adapted to the stomach. It is desirable, however, in any case that a special line of suture should be employed to unite the edges of the mucous membrane. For the outer row there is nothing better than the interrupted Lembert suture.

The parts having been well cleansed, the gauze is removed, and also the guiding loops of silkworm gut from the stomach wall.

The parietal incision is closed in the usual way.

After-treatment.—This should be carried out upon the lines indicated in other abdominal operations. (*See* page 118.)

Little food should be given by the mouth for two days. The patient should not be allowed to suck ice; there is no object to be gained by practically starving the patient; the stomach becomes irritable under such treatment. The diet for some ten days should be of the simplest and most easily-digested character, and the food should be given in small quantities and at frequent intervals.

Comment.—The incision in the stomach may need to be of considerable size. In Mr. Thornton's case the foreign body consisted of a ball of hair, and the gastric wound, after it had been closed by sutures, measured three inches.

Dr. Richardson, of Harvard, succeeded in 1886 in removing a plate of teeth which were impacted in the lower end of the gullet, and which were reached through an opening made in the stomach. The whole hand was introduced into the stomach before the removal could be effected. Dr. Richardson advises a long oblique incision close to the margin of the left costal cartilages.

3. OPERATIONS ON FIBROUS STRICTURE, OR HOUR-GLASS CONTRACTION OF THE STOMACH

In most cases the stricture is at or close to the pylorus, but the contraction due to the healing of a large ulcer towards the centre of the stomach may lead to the condition of hour-glass stomach—*i.e.* where the stomach is divided into two pouches. The intervening constricting part is apt to be taken for the pylorus. The operations which have been found useful for this condition are many, but the main principles of them are discussed elsewhere (under the headings Pyloro-plasty and Gastro-enterostomy). It is therefore unnecessary here to do more than note the chief methods which may be indicated for the relief of hour-glass stomach. These are mainly taken from an excellent article on the subject by Mr. Moynihan (*Brit. Med. Journ.*, Feb. 20th, 1904).

(1) If the pouches are very unequal in size, the larger being

that into which the œsophagus opens, gastro-jejunostomy (see page 211) will suffice.

(2) If the pouches are fairly equal in size and bulge downwards side by side, the surgeon's choice lies between gastroplasty, performed in exactly the same way as a plastic operation on the pylorus, excision of the strictured portion, with immediate union of the two halves of the stomach, or the making of an anastomosis between them below the strictured part, or, finally, doing a double gastro-jejunostomy, thus draining both pouches.

Where the two pouches are of approximately equal size and the pylorus is normal, the best operation seems to consist in making a free opening between the two dilated portions. The stomach wall is grasped on either side of the constriction by a pair of clamps. These clamps are then approximated, the space around and beneath them being packed with gauze. A continuous suture of silk is used to bring the serous layer on either side in contact. In front of this two equal linear openings are made into each pouch, and an elliptical portion of the mucous membrane is removed with scissors. The openings should be at least two to three inches in length, the longer the better. A continuous suture is then passed through all the coats on either side, and a continuation of the serous suture in front of the opening completes the operation. The method will be understood by reference to Figs. 53 and 54.

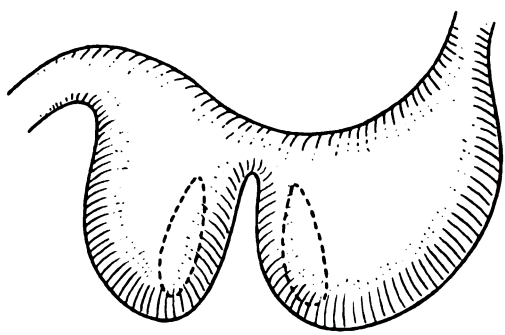

FIG. 53.—HOUR-GLASS STOMACH.

The area on each pouch which is circumscribed by the dotted line indicates the part to be seized by the clamps and then opened.

It is essential not to mistake one of the dilated pouches for the whole stomach, as has been done in several recorded cases. Sometimes there is contraction of the pylorus in addition to

the centre of the hour-glass. Hence, in operating on such cases the whole of the stomach should be carefully made out on opening the abdomen before deciding what method to employ. The extent of cicatricial tissue and the condition of the patient will determine to some extent what method is the best, and sometimes it is necessary to perform two operations with an interval. Gastro-jejunostomy is both quicker and safer than

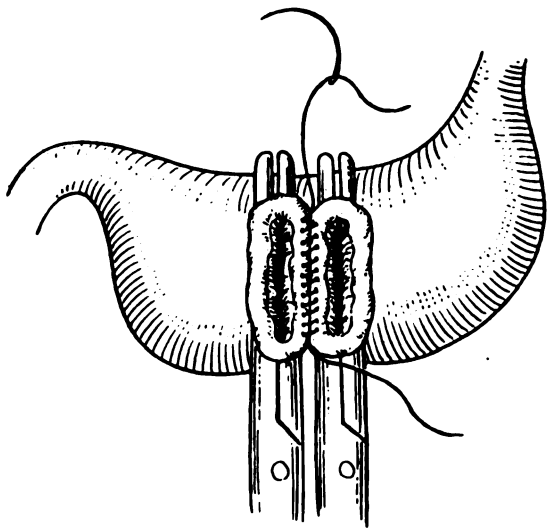

FIG. 54.—HOUR-GLASS STOMACH.

A continuous suture fixing the outer coats is introduced, each pouch is freely opened, and a continuous suture is then passed all round the orifice on each side through all the coats. Finally the suture shown will be continued on the anterior surface.

such an operation as complete excision of the strictured part, and should be performed when the patient is in bad condition at the time of operation. Sometimes, after the main pouch has been drained by a gastro-jejunostomy, a second plastic operation has been successfully carried out after a few weeks' interval. The difficulties attending operation in some of these cases are very great. Thus the constricted part of the stomach may be found so firmly adherent to the liver, the pancreas, or the anterior abdominal wall, as to render any plastic operation out of the question. In separating such adhesions, severe bleeding

may occur, or the thinned stomach wall may give way. The long-continued vomiting and emaciation (perhaps repeated hæmatemesis) may render any operation dangerous. Mr. Moynihan records a total of nineteen cases of hour-glass stomach operated on by himself; of these, four proved fatal, but in one of them the sequel showed that the stricture had been malignant and not simple. In the remaining fifteen the recovery was most satisfactory. This proportion (80 per cent. of cures after operation for hour-glass stomach) is surprisingly favourable.

Dilatation of the Pyloric or Gastric Stricture (Loreta's Operation).—In the first edition of this work a full account was given of the method of digital dilatation of a contracted pylorus, performed through an opening made in the stomach on the proximal or dilated side. The risk attending this operation, its difficulties, and its failure to give lasting benefit, have led surgeons entirely to abandon Loreta's operation in favour of either of gastro-jejunostomy or pyloro-plasty. Digital dilatation has, however, been employed with success in some cases of congenital (hypertrophic) stenosis of the pylorus, and is more appropriate in these than in the examples of true cicatricial contraction in adults.

Dilatation of an Œsophageal Stricture from the Stomach.—When a traumatic stricture is situated at or near the cardiac orifice, it may be stretched from below by means of gastrotomy sufficiently to allow the passage of bougies from the mouth—a procedure which had been previously impossible. The opening into the stomach should be made on its anterior surface as near to the diaphragm as practicable, and it will require to be fairly large. In a successful case recorded by Mr. E. O. Ashe (*Brit. Med. Journ.*, Sept. 9th, 1905), the cardiac orifice could not be reached until the wound was sufficiently enlarged to admit the hand. Conical bougies were introduced, followed by stretching with curved clamp forceps. The stretching was attended with marked respiratory inhibition. The stomach wound was completely sewn up, the whole operation lasting nearly two hours. The regular passage of bougies from the mouth was subsequently

carried out. Several similar cases have been recorded, and the method, though a difficult and uncertain one, should certainly be tried in those cases of traumatic stricture in which dilatation from above has been carefully tried without success, and in which the patient is threatened with starvation. It is, of course, only suited for fibrous stricture, being contra-indicated in malignant disease. Mr. Moynihan records a case of similar retrograde dilatation of a stricture of the body of the stomach after gastrotomy which proved successful. Extensive adhesions of the stomach rendered a more formal operation impracticable, and at the time he regarded the thickening as malignant, the event proving this to be a mistake (Moynihan's "Abdominal Operations," page 194).

4. PYLORO-PLASTY

By this term is understood a plastic operation, for the relief of fibrous stricture of the pylorus, in which no part of the stomach wall is excised. It may be equally well carried out on any part of the intestine, but only when the stricture is ring-like, and does not involve much of the length of the gut. It is quite unsuited for cases of malignant disease. Its principle is simple. The narrowed part having been well defined, the stomach is opened to one side of the stricture, and a broad director (the old-fashioned hernia director is best) is passed through; on this the narrowed wall is completely divided into healthy tissue on the other side of the stricture. The longitudinal wound is then converted into a transverse one, by means of traction made with two hooks placed at the centre of either border. A double row of stitches is then applied, the deeper sutures (which may well be continuous) going through mucous membrane and submucous tissue, the more superficial being the usual interrupted Lembert's stitches, which involve the serous and muscular coats. The hooks being withdrawn, an extra stitch is applied at either end, and the operation is completed by careful cleansing of the peritoneal surface of the pylorus and closure of the abdominal wound. The method will be readily understood by reference to Fig. 55. It has been largely employed for cicatricial stenosis following ulcer of the stomach, and occasionally when an active ulcer has been excised from the duodenum or pylorus with the view of preventing subsequent stricture.

Pyloro-plasty displaced stretching with the finger (Loreta's operation), and is certainly safer and more efficient, but on the permanency of its results much doubt has been thrown, since many cases of pyloric stricture in which it has been performed have required subsequent gastro-jejunostomy, although the patients were relieved for a time. It is easy to see why the operation may fail in its object, since by doing it the surgeon actually increases the amount of scar tissue; further, the cicatrix left by an ulcer of the pylorus is rarely a perfect ring, and the operation is quite unsuited for broad, irregular scars.

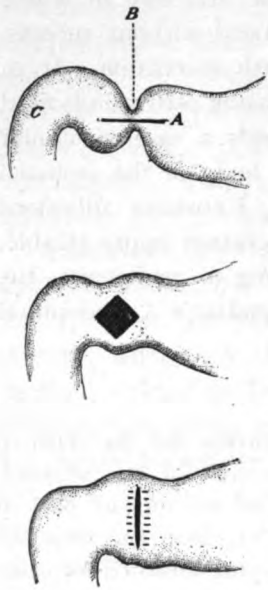

FIG. 55.—THE THREE STAGES OF PYLORO-PLASTY.

The upper figure shows the incision through constricted portion (B) from stomach (A) to duodenum (C). In the middle figure the wound is held open with hooks so as to become lozenge-shaped. In the lower figure it is again converted into a linear wound and sutured up in the form shown. (Diagrammatic.)

Hence, if the pylorus is much scarred or distorted it is safer to do a gastro-jejunostomy. If the surgeon attempts a pyloro-plastic operation, and is dissatisfied with the immediate result, he should certainly go on to perform the former—*i.e.* to anastomose stomach and jejunum. In an interesting case in which this course was adopted by Mr. Rushton Parker (*Brit. Med. Journ.*, Feb. 11th, 1905) the patient died about three years later from perforating ulcer of the jejunum. The pyloric orifice, which had been the site of the plastic operation, was as hard as cartilage, *and would hardly admit the tips of the scissors.*

From the guarded way in which the operation of pyloro-plasty has been discussed the reader will infer that our opinion of it is unfavourable. It has had an extensive trial, which, according to those with most experience in performing it, has resulted in an adverse verdict. It is undoubtedly ingenious, and might be expected to give a good and permanent result, but this has not been found to be the case. Even when limited to the cases for which alone it is suitable, those of fairly narrow fibrous stricture, recurrence of contraction is often met with after a year, or less. Moreover, gastro-jejunostomy is so successful that the position may be summed up in the words

of a surgeon with much experience in stomach operations: "I have done pyloro-plasty many times, but I shall never do it again."

5. RESECTION OF THE PYLORUS AND GASTRECTOMY

History and Object.—Pylorectomy consists in removing the pylorus, together with the adjacent parts of the stomach and of the commencement of duodenum. After the excision the divided walls of the stomach and the bowel are brought together, and united by sutures.

The operation has been performed on account of non-malignant disease in a few isolated cases, the condition being that of pyloric ulcer or of pyloric stenosis. Apart from these unimportant exceptions, the operation has been limited to cases of cancer involving the pyloric orifice of the stomach.

The possibility of excising the diseased pylorus was suggested by more than one surgeon about the beginning of the last century. Experiments upon animals made by Günther, Gussenbauer, Winiwarter, Wehr, and others, at a later period, demonstrated the possibility of the operation.

The first operation upon the human subject was performed by Péan in 1879, and the second by Rydygier in 1880. Both patients died. The first successful operation was carried out by Billroth in January, 1881.

Pylorectomy has been somewhat extensively performed in Germany, but the operation has not been received with much favour in Great Britain. Care in selecting suitable cases and improvements in method and details of operating have, however, reduced the direct mortality during the last ten years; but, with a few rare exceptions, the cancer "returns" within six months or a year, usually in the liver or lymph-glands. In 1897 the surgical world was startled to hear that the whole stomach had been successfully excised in a case of carcinoma by Dr. Schlatter of Zürich. Hartmann, Moynihan, and others have urged and practised a wide excision of the stomach when the extent of the cancer justifies it.

Mr. A. E. Barker, Mr. Mayo Robson, Mr. Rutherford Morison in England, Prof. Kocher, and many other surgeons have described modifications of the operation, especially in the method of uniting

the stomach to the intestine. If the resection be very extensive, the direct union of stomach to first part of duodenum will not be possible, and then the best course will be to close both ends completely by a double row of sutures and to perform a gastro-jejunostomy. It has been proved by Schlatter's case that a patient can live in comfort for at least a year after the whole stomach has been removed. In many others the removal of a large part of the stomach has not interfered with the digestive powers of the patient. It is more important to keep wide of the cancer than to attempt at all hazards to bring stomach and duodenum together at the risk of an imperfect excision of the tumour. Hence Billroth's original operation of pylorectomy has largely given place to a more extensive gastrectomy. That the prognosis as regards ultimate recurrence has been much altered is, however, doubtful, though the date of recurrence has been somewhat deferred in many cases. An admirable account of the operation of pylorectomy and its modifications is given by Hartmann in his "Chirurgie Gastro-Intestinale" (Paris, 1901), and in what follows, this account, as well as those of Barker, Billroth, and others, has been utilised.

Anatomical Points.—The chief arteries concerned in the operation of pylorectomy are the coronary, coming direct from the cœliac axis (Fig. 56), and the gastro-duodenal branch of the hepatic. It is advisable to secure these by ligature at an early stage of the operation. (*See* Fig. 49, page 172.)

The lymphatic glands first infected by a pyloric cancer are those lying along the lesser curvature, between the layers of the gastro-hepatic omentum, and a chain situated below the greater curvature in the meso-colon. These, if enlarged, may be removed in one piece with the excised portion of stomach. But if infected glands can be felt close to the liver or in front of the vertebral column behind the pylorus, excision of the diseased pylorus is useless, and the surgeon should content himself with the temporary relief afforded by gastro-jejunostomy. There are further limitations. Pyloric cancer tends to infiltrate the peritoneum above and below, to contract adhesions to the pancreas

and liver. Secondary nodules may form early in the liver, and their discovery as a rule negatives the idea of resection. Nodules in the wall of the transverse colon, in the great omentum or the parietal peritoneum, are unfortunately common with pyloric cancer. In the absence of such secondary deposits the chief point to ascertain is that the stomach is free from adhesions

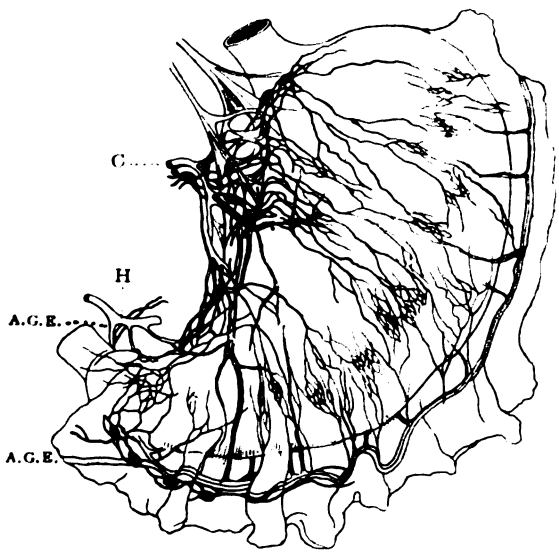

FIG. 56.—LYMPHATICS AND ARTERIES OF THE STOMACH. (From Hartmann's "Chirurgie Gastro-Intestinale.")

C, Coronary artery; H, Hepatic artery with its pyloric branch and (A.G.E.) right gastro-epiploic. The lymphatics from the pyloric end of the stomach are seen to end in glands situated along the lesser curvature, and also in others below the great curvature.

due to cancerous infiltration. This may be ascertained by making small apertures in the thin lesser omentum and meso-colon; with the finger introduced through these the mobility or otherwise of the pylorus can be ascertained. Unless it is mobile, resection should not be attempted.

Preparation of the Patient.—The stomach at the time of the operation should be empty. For a week or more previously to the operation the diet should be very carefully regulated; and if sufficient food cannot be taken by the mouth, such feeding must be supplemented by nutrient enemata.

Peptonised milk appears to be the most suitable food to be given by the mouth, and it may be supplemented by certain prepared foods, beef-tea, custard, and such other simple articles of diet as are readily taken by the patient and are well borne. Some operators attach importance to the sterilisation of all food taken for some time before this and other operations on the stomach.

Some advise that for a few days before the performance of the excision the stomach should be washed out daily, either with warm water or with some very weak warm antiseptic solution. This preliminary washing is, however, not essential.

The washing-out of the stomach is best effected by means of a syphon irrigator, or "syphon stomach-tube." Reversible stomach-pumps—and indeed all forms of stomach-pumps—are to be absolutely avoided.

The stomach may be washed out for the last time one or two hours before the anæsthetic is given. It will, however, suffice if the only washing-out be done on the table immediately before the operation.

The bowels must be thoroughly evacuated by enemata.

The usual antiseptic preparation of the skin should be carried out.

Every arrangement must be made to prevent undue loss of heat from the patient's body. The extremities should be enveloped in warm flannels, and a good supply of hot bottles should be at hand, to be employed directly after the operation.

It must be remembered that the operation involves a considerable time, and is attended with no small degree of shock.

The general arrangement of the table, the accessories of the operation, and the position of the surgeon and his assistants are the same as in other abdominal operations. (*See* page 97.)

Instruments Required.—Scalpel; blunt-pointed bistoury; dissecting and artery forceps; twelve pairs of pressure forceps; large pressure forceps; volsella; blunt-pointed scissors, straight and curved; sharp-pointed scissors; broad spatulæ; rectangular retractors; intestinal clamps; fine-toothed forceps;

straight and rounded intestinal needles; needle-holder; aneurysm needle; blunt hooks; sponge-holders; fine silk; catgut; straight or curved needles and suture material for the parietal wound.

One of the best forms of clamp for resection of stomach or intestine is that introduced by Sir T. Smith, which is practically identical with that called Doyen's clamp. Makins's clamp also is on the same principle. These instruments consist of two long supple arms of metal, which are approximated by clamp or screw pressure. Two pairs will be necessary. Smith's, Doyen's, and Makins's clamps may be compared in Figs. 76, 77, and 78. Many other slightly modified clamps are on the the market, each with a different surgeon's name attached.

The Operation.—The *first stage* is necessarily an exploration to decide whether a malignant growth exists or not, and whether the case is suitable for excision. A vertical incision an inch to the right of the middle line, made from the costal margin to near the umbilicus, is the most suitable one. Through this pylorectomy or gastro-jejunostomy can usually be effected, whilst if more room is required a transverse incision through one or other rectus muscle can be added to it. The severance of the muscle, however, makes it more difficult to close the abdominal wound well, and predisposes to a ventral hernia; it should therefore be avoided if possible.

The edges of the peritoneal wound are held aside by catch forceps or suture retractors; the surgeon then ascertains the presence of the pyloric tumour and its nature. In most cases of carcinoma the diagnosis can readily be made on inspection of the tumour, but it should be remembered that the induration around a chronic ulcer at the pylorus may closely simulate a new growth. If there is no doubt as to the stomach being the seat of cancer, the following questions must be decided:—

1. Are there secondary deposits in the liver or scattered about the abdomen?
2. Are the lymphatic glands in the transverse fissure of the liver obviously enlarged?

3. Has the growth contracted firm adhesions to important organs, especially the pancreas, liver, or colon? Is the tumour firmly fixed?

4. Does it extend for some distance into the duodenum?

If either of these conditions is present, pylorectomy is not advisable—the surgeon must content himself with performing gastro-jejunostomy; or, if no marked obstruction is present and the growths are widespread, it may be best simply to close the abdomen again. It is presumed that the conditions are favourable for excision of the growth.

Second Stage, Isolation of the Pylorus.—This is the most difficult and the most tedious part of the procedure.

The lesser omentum and meso-colon are perforated above and below the growth, as already described. The growth is drawn as far as possible into the wound, and a number of gauze-pads (duly counted) are carefully packed around the stomach and pylorus, in order to prevent extravasation into the peritoneal cavity. To each pad a long tape is attached, the end of which lies outside the abdomen.

Slight adhesions to adjacent parts are divided, and the pylorus is freed as far as is possible.

The great omentum is now divided close to the greater curvature, and over as small an area as is consistent with the efficient removal of the growth. It should be clamped in segments by means of two pairs of pressure forceps. The omentum is divided between the forceps, and is then ligatured upon the distal side of either pair. In the place of this the omentum may be dealt with in sections, which are isolated by means of double ligatures passed on an aneurysm needle. The segments thus secured are divided between the ligatures, which must be carefully tied.

The lesser omentum is treated in the same manner.

Any enlarged glands observed must be removed. Special attention should be directed to the group of glands along the lesser curvature, close to the coronary artery. The latter vessel should be ligatured at this stage close to the point at which the

clamp will be applied. The gastro-epiploic arteries on either side of the intended excision line should also be secured. This preliminary ligature takes a few minutes, but is worth doing, as it renders the later stages of the operation easier.

When the pyloric mass is free, a large gauze-pad is passed beneath it, and the other pads packed around the part must be rearranged.

Both the stomach and the duodenum are now clamped upon either side of the part to be removed.

The duodenal clamp may be dispensed with, but it is essential to apply one to the stomach, well on the proximal side of the growth. A second clamp is then fixed near to the other, so that when the stomach is divided no extravasation of its contents can occur.

Third Stage, Excision of the Diseased Parts.—The stomach is divided completely across between the two clamps with straight scissors, the line of section passing obliquely upwards from left to right. The free pyloric portion—held in the clamp—is now turned over towards the left until the commencement of the duodenum beyond the growth is reached. The gastro-duodenal artery is here excised and ligatured close to its origin from the hepatic. If a clamp has not already been applied here, this is done, and the scissors now divide the duodenum at right angles. The diseased portion, after any part of the mesentery still attached has been severed, is then removed.

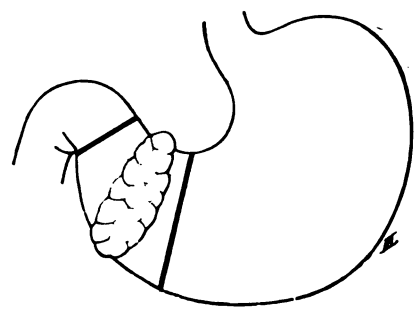

FIG. 57.—EXCISION OF PYLORUS, ETC.

The position of the incision across the stomach will vary according to the extent of the growth, and may include much more of the stomach than is here shown.

Fourth Stage, Union of Stomach to Intestine.—If the duodenal end can be brought without undue tension directly in contact with the severed portion of stomach, the two are directly

united by suture. The two clamps are brought parallel to each other and near together, a sufficient amount of stomach and duodenal wall protruding beyond each to allow of the sutures being introduced. The two sections will not correspond in size, that of the stomach being often considerably larger. As the surfaces are linear it is easy to see how much of the stomach section must be closed to make them correspond. The duodenum must be sutured to the lower portion of the stomach, starting from the great curvature. The superfluous part above is at once closed by a continuous suture of fine silk which traverses all the coats. A similar continuous suture is then made to unite the duodenum to the stomach, leaving an opening the full size of the former. A second suture is now passed through the outer coats only all round the line of union, the clamps are removed, and any weak spot strengthened by a few interrupted Lembert's sutures. The closed upper end of the stomach wound is now drawn down to the top of the duodenum and fixed by a few Lembert's sutures. This completes the resection with end-to-end union, but it has been noted that this method is only suitable for certain cases, those in which the growth is limited to the pyloric region, and in which the stomach wall is not widely invaded. Some surgeons discard it entirely, but it is a good method and has given satisfactory results.

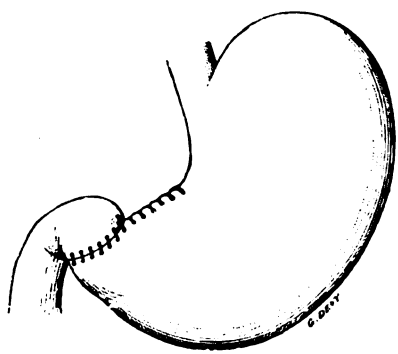

FIG. 58.—EXCISION OF PYLORUS WITH END-TO-END SUTURE.

We will now consider some alternatives, in which the stomach wound is entirely closed. This is quickly and easily effected, before the clamp is removed, by a double row of continuous suture, the first traversing all the coats, the second the outer ones only. The cut end of the duodenum is now examined, if it is long enough to allow of implantation into the posterior

surface of the stomach (Hartmann's and Kocher's method), this is done in the following manner (Fig. 59):—An assistant steadies the already sutured stomach with both hands, rotating it so that the posterior surface turns forwards. A continuous line of suture, through outer coats only, is made to fix the posterior edge of the duodenum to the back of the stomach; just in front of this an aperture is cut in the latter of the same size as the

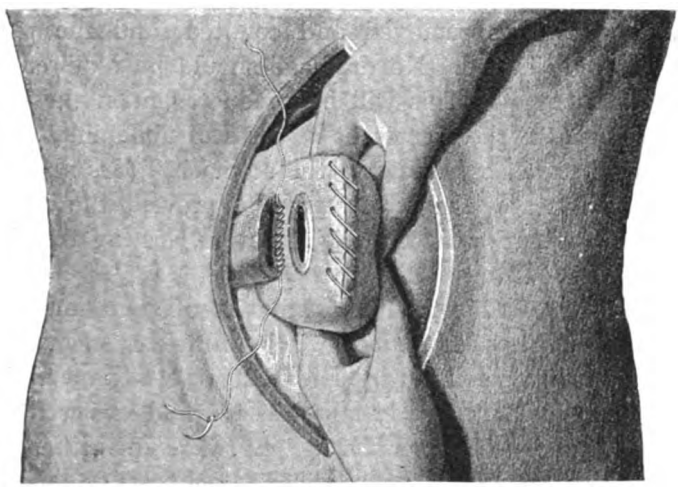

FIG. 59.—PYLORECTOMY, SHOWING IMPLANTATION OF DUODENUM INTO OPENING MADE ON POSTERIOR SURFACE OF STOMACH. (From Hartmann's "Chirurgie Gastro-Intestinale.")

The section of the stomach is already closed by a double row of continuous sutures.

duodenum end. The latter is then implanted and fixed by the usual double continuous suture.

It will be understood that the new pylorus is placed posteriorly and somewhat above the remains of the greater curvature.

Kocher's method should, however, not be attempted if the section of the duodenum has had to be made so far to the left that a suitable "stump" is not left free. Serious accidents, such as wound of the common bile duct, of the portal vein, or of the pancreas, have happened during the attempt to isolate and free the duodenal portion. If there is any doubt as to the possibility of union being safely made between stomach and duo-

denum, the idea should be abandoned, and gastro-jejunostomy resorted to. As a preliminary step the end of the duodenum is firmly closed by a double row of sutures. In our opinion, posterior gastro-jejunostomy is certainly better than anterior in such circumstances. No special description is required, as the details will be the same as those given on page 211.

Completion of the Operation.—The whole field of operation is carefully cleansed, the sutured viscera are gently replaced, all pads or sponges removed and counted, and the parietal wound carefully closed. No drainage should be required.

After-treatment.—This will be conducted upon the general lines laid down in the treatment of cases of abdominal section, and especially such as implicate the stomach. (*See* pages 118-123.) Every measure must be taken to prevent the effects of shock. The operation is of long duration, lasting two hours or even longer.

The feeding of the patient is a matter of great importance. The strength cannot be maintained by nutrient enemata, and by ice taken by the mouth. The best results have followed in cases where food was early administered and was well borne. Peptonised milk or Benger's food in small quantities, meat juices, or jelly, should be given as soon as possible. Nutrient enemata, if well tolerated, should also be employed for the first few days. The patient will do far better if raised somewhat on pillows than if kept rigidly supine.

Results.—The immediate mortality of the operation has greatly improved from the time that Billroth introduced it thirty years ago. Up to 1885 the deaths were probably at least 60 per cent.; they are now, in the hands of competent surgeons, about 30 to 40 per cent. The improvement has been due partly to asepsis and attention to detail, but still more to the selection of cases suitable for the operation and its early performance. The deaths occur mainly within twenty-four or forty-eight hours, from peritonitis, collapse, or shock. The operation must of necessity be a long and difficult one, with grave risk for patients already exhausted by pain, vomiting, and semi-starvation.

The mortality must be compared with that of gastro-jejunostomy done in cases of pyloric cancer. Such a comparison on a very large scale is afforded in a recent work by Kucke. Although the figures are more discouraging than some writers would lead one to expect, they are the more valuable for their perfect candour. Kucke collected records of 563 cases of gastro-enterostomy from four Continental clinics, with 216 deaths—*i.e.* 40 per cent.; 216 cases of pylorectomy for cancer resulted in 104 deaths—*i.e.* a mortality of 48 per cent.

Probably the great majority of the cases for which gastro-enterostomy was done were examples of malignant disease, otherwise the very high mortality would be difficult to account for.

The influence which extensive adhesions have upon the result of the operation is well shown by Saltzmann.

In fourteen cases without adhesions the mortality was 35.7 per cent., in seventeen with slight adhesions the mortality was 64.7 per cent., and in twenty-six cases with extensive adhesions it was 91.5 per cent. The deduction is obvious that where the pyloric growth is found to adhere firmly to liver, pancreas, or colon the surgeon is not justified in attempting its excision. We may assume that, with careful selection of cases, about 50 to 60 per cent. of the patients on whom excision of cancer of the stomach is performed recover from the immediate effects of the operation. What is their ultimate chance? How far is their life prolonged? Unfortunately, the answer to this question is neither satisfactory as regards the past nor hopeful for the future. However free the excision, whatever care may be taken in removing neighbouring lymphatic glands, recurrence of growth is almost certain to happen within two or three years. The recurrence takes place most commonly in the liver, in the deep abdominal glands, and in the general peritoneum.

It is true that there have been a few cases recorded in which an apparent cure for many years has occurred. Thus one of Billroth's patients was alive and in good health ten years after

pylorectomy (for supposed cancer) with end-to-end union. Similar isolated cases have been reported by other surgeons.

It is, however, probable that these were not cases of true cancer, but of chronic non-malignant ulcer of the pyloric region. In cases of true gastric cancer which are suitable for excision the patient may be restored to good health for a period varying from a few months to three years. This has been our own experience, and it is borne out by that of many surgeons. Unfortunately, respite for more than a year or eighteen months is quite exceptional.

6. GASTRO-JEJUNOSTOMY

This operation consists in establishing a permanent communication between the stomach and the first coil of the jejunum just below the end of the duodenum. It was first proposed as a substitute for pyloric resection in cases of cancer of that part of the stomach, but its use has been largely extended.

The procedure was devised and carried out by Wölfler in 1881 (*Centralblatt für Chirurgie*, Nov. 12th, 1881). It was found that the obstruction was overcome by diverting the course of the food matters, that the patient was greatly relieved, that life was prolonged, and that no grave gastric symptoms supervened. In course of time it became evident that gastro-enterotomy was not so much a mere substitute for pylorectomy, or a *dernier ressort* when excision could not be practised, but an operation that in its results could be fairly compared with the older operation, and could be considered to be in many respects superior to it.

The result of gastro-jejunostomy in average cases of pyloric cancer may be thus stated: The patient loses the distressing symptoms of pain and vomiting, he becomes able to digest solid food without discomfort, and, in consequence, gains weight to a surprising degree. This condition of improvement lasts from two to six months, possibly twelve, during some of which time he may be able to return to work. Ultimately wasting again comes on with the progress of the cancer and its extension in

the liver, etc.; the sickness probably returns, and the patient dies from cachexia or some intercurrent pneumonia, etc. In not a few instances, however, to the surgeon's surprise, the improvement is maintained year after year; it is unlikely that there has been cancer in these cases. It is practically impossible to distinguish, short of prolonged microscopic examination, the indurated lumpy pylorus associated with chronic ulcer of this region from cancerous stricture. In both conditions the lymphatic glands may be markedly enlarged. There is little doubt that most, if not all, of the permanently successful cases of pyloric resection for cancer have been really of chronic inflammatory nature.

Hence the asserted advantage of pyloric resection over gastro-jejunostomy for cancer in obtaining a permanent cure in some cases falls to the ground. When such a result is obtained from either, the diagnosis has probably been mistaken.

The main test is therefore the direct mortality of the two operations—and here there is no question as to the lesser risk of gastro-jejunostomy.

Nevertheless, the swing of the surgical pendulum has of late been in the direction of excision (pylorectomy or partial gastrectomy) when it can be performed with reasonable prospect of success. The respite is certainly longer than after gastro-jejunostomy for cancer.

The operation of gastro-jejunostomy has been extended to cases of chronic ulcer of the stomach (1) when attended with recurring and severe hæmatemesis; (2) when stenosis has occurred at or near the pylorus due to cicatrisation of an ulcer; (3) when hour-glass contraction has developed from the same cause; and (4) when symptoms of gastric ulcer have continued for some considerable time and have resisted careful dieting and medicinal treatment.

The object of the gastro-jejunostomy under these conditions is twofold—to relieve obstruction to the stomach by emptying its contents, and by giving rest to the organ to encourage healing of the ulcer.

Gastro-jejunostomy has of late also been performed for simple pyloric stenosis (not associated with ulcer) which is apparently due to congenital hypertrophy of the muscular ring or to the valvular fold being too pronounced. It may be required in young children or in adults; curiously, nearly all the cases in the latter have been females. Mr. A. E. Maylard (*Clin. Trans.*, 1904, page 63) records seven cases of this kind in adults, all treated successfully by posterior gastro-jejunostomy performed by the method described on page 211.

History, etc.—The operation, as already noted, was introduced by Wölfler in 1881. The subsequent literature on the subject is voluminous. Wölfler, Mickulicz, and Sonnenburg in Austria and Germany; Hartmann in France; Murphy and others in the United States; and Herbert Page, A. E. Barker, Mayo Robson, and Moynihan in this country, have made valuable contributions. A valuable account of experimental work in this operation and in lateral anastomosis generally is given by Messrs. Ballance and Edmunds in the *Med.-Chir. Trans.* for 1896, pages 255 to 311.

Much discussion has taken place as to the relative advantages of anterior and posterior gastro-jejunostomy, but it will be most convenient to refer to this subject after describing the method of performing each operation.

In all cases of gastro-jejunostomy the first coil of small intestine below the fixed duodenum must be attached to the stomach (*see* Fig. 60). Not only is the wall of this part of intestine thick and well adapted for suturing, but it is also important that food should pass from the stomach into the upper end of the gut so that digestion may be properly carried out. Thus, whatever method be employed, the surgeon must first find the termination of the duodenum, which is fixed in front of the aorta behind the transverse colon. The demonstration of the commencement of the jejunum is best effected by drawing the transverse colon upwards and by then passing the fingers along the under-surface of the transverse meso-colon until the vertebral column is reached. Just to the left of

spine the terminal part of the duodenum will be discovered. This will lead to the jejunum, and traction upon the coil seized will demonstrate that it represents the very commencement of the jejunum.

It is important to favour, as far as is possible, the contents of the stomach passing into the descending limb of the jejunal loop. For this reason, the intestine should be so sutured that

FIG. 60.—POSTERIOR GASTRO-JEJUNOSTOMY. (From Hartmann's "Chirurgie Gastro-Intestinale.")

The transverse colon is raised and part of the stomach has been drawn through an aperture made in the transverse meso-colon. The loop of the jejunum has been fixed to the stomach obliquely, the opening made between the two organs is being evenly secured all round by a continuous suture of silk.

its axis may correspond with that of the stomach—*i.e.* both running from left to right. Further, the direction of the loop secured should be obliquely downwards. This will be readily understood by reference to Fig. 62.

The jejunum is fixed to the stomach for a length of about three inches, the central two inches representing the actual aperture of communication. The fixation of the two in either side of the aperture ensures the absence of kinking.

Instruments Required.—These are of a simple kind, and no special instruments are needed besides a pair of straight clamps. Murphy's buttons were at one time often employed but nearly every surgeon has given them up for simple suturing. Robson's and other forms of bone bobbins are, in our opinion, quite useless.

Preparations for the Operation.—The usual antiseptic preliminaries have been carried out. A sand-bag beneath the upper part of the abdomen is often convenient. It is unnecessary to expose more than the region between the umbilicus and the sternum. Dry, hot, sterilised towels are carefully arranged all round this area.

It is desirable that the stomach should contain as little fluid as possible, and a preliminary lavage through a long rubber œsophageal tube should be carried out before the anæsthetic is given.

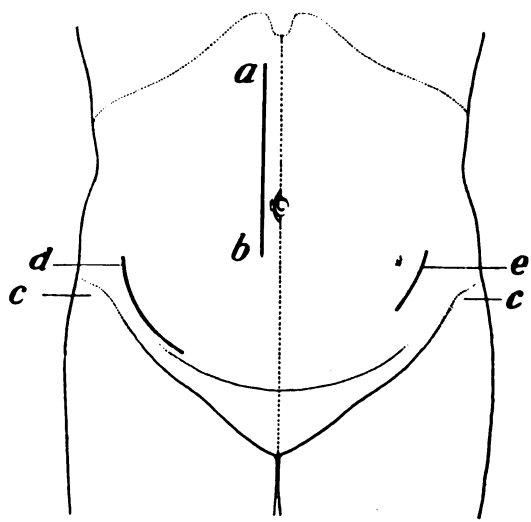

FIG. 61.—THE INCISION (*a b*) USUALLY EMPLOYED FOR GASTRO-JEJUNOSTOMY AND OTHER OPERATIONS ON THE STOMACH.

c c, Anterior superior spines of ilia; *d*, Incision for reaching the right ureter extra-peritoneally; *e*, Incision for left inguinal colotomy.

(1) **Anterior Gastro-jejunostomy by Suturing.**—The abdomen is opened in the middle line above the umbilicus, and the stomach region explored. The great omentum is pushed to the right side of the abdomen, the first coil of jejunum is identified in the manner described (p. 206), and is then drawn forwards in front of the transverse colon, so that it can be brought in contact with the stomach. The

anterior wall of the latter is brought out of the wound, as well as the piece of jejunum, and both are packed round with sponges or gauze compresses. Care is taken that there is no strain put upon the jejunum when it is drawn into place. If the loop of jejunum be too short it acts as a strap across the transverse colon, and drags upon the stomach. The selected coil of jejunum is held by an assistant, whose fingers act as compressors. No clamps are needed. The stomach also is drawn into the parietal wound, and the point at which it is to be opened decided upon. A linear incision, one and a half inches in length, is now made through the outer coats only of both jejunum and stomach, the incisions being exactly opposite to each other. With a needle threaded with fine silk a continuous suture is passed parallel to the two incisions and posterior to them; this is knotted at each end, and the two surfaces of stomach and jejunum are thus brought closely together. The free ends may be left long and secured with forceps. The suture should take a firm hold, going as deeply as the submucous layer in each viscus. The intestine is now opened by completing the incision already begun and by cutting through the mucous coat; this is best done with a tenotome and completed with scissors. The same step is carried out in the stomach, any gastric juice that escapes being at once mopped up with

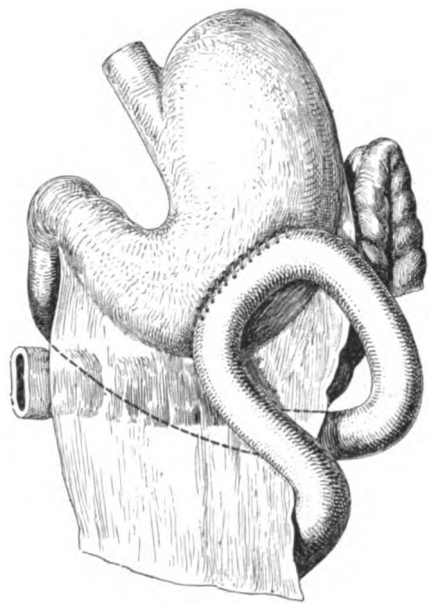

FIG. 62.—ANTERIOR GASTRO-JEJUNOSTOMY. (From Hartmann's "Chirurgie Gastro-Intestinale.")

A loop of the jejunum is drawn in front of the great omentum and transverse colon, and is fixed to the anterior wall of the stomach. The opening between the two has been made, and the final continuous suture is shown drawing the outer coats of the two viscera together.

sponges. Any bleeding vessel should be seized with a Wells forceps. A second line of continuous suture is carried through the posterior side of the opening—*i.e.* the side already dealt with—the needle traversing all the coats. It is often advisable to cut away with scissors the protruding edges of the mucous membrane. It only remains to make a third line of suture through the outer coats in front of the opening—*i.e.* to cover in the continuous suture just made. In cutting through the stomach and intestine walls some small arteries are sure to bleed, but they rarely require ligature, as clamping with Wells' forceps for a few minutes suffices to stop them. All sponges being counted and removed, the sides of the abdominal wound are held forward so that the stomach and the jejunum slip back, and the wound is closed in the usual manner.

The method of suturing employed in the above operation will perhaps be rendered clearer by recapitulation. The two linear incisions made through the outer coats only of stomach and jejunum should be of exactly the same length; they mark the size and position of the anastomotic opening. The first row of stitches, which takes a firm hold of all but the mucous coats, fixes the opposite surfaces of the two viscera together behind the linear incisions; it saves time to use the continuous suture, knotting it after every three or four insertions of the needle. Many operators employ interrupted sutures. The next step is the completion of the opening into both stomach and jejunum in front of the row just described. If the mucous membrane bulges, any redundant portion is cut away with scissors. The second row of sutures brings the edges of the opening into stomach and jejunum respectively into close contact all round; here also the continuous method is the best and most rapid. The third row, which is practically a continuous Lembert suture, is shown in Fig. 62; it traverses only the outer coats. Two or three additional Lembert's sutures at either end may be required to take off the strain on the others, and to prevent sharp kinking of the intestine.

(2) **Posterior Gastro-jejunostomy by Suturing.** — The

method differs from the preceding in the following respects :— The transverse colon and great omentum are turned upwards, and the under layer of the meso-colon is exposed. An aperture is made in the latter, avoiding the branches of the superior mesenteric artery and vein. Through this aperture the posterior wall of the stomach is drawn, a sufficient area being exposed in which to make the anastomosis. Four or five sutures are so applied as to fix the edges of the opening in the meso-colon to the stomach wall. These sutures should only penetrate the outer coats of the stomach. Care should be taken to make the aperture in the meso-colon large enough. We have heard of a case in which a too small opening in this layer of peritoneum subsequently led to narrowing of the gastro-jejunal aperture.

The commencement of the jejunum is then drawn forward so that the part which is directly continuous with the duodenum can be placed in apposition with the area of stomach already circumscribed. It is important to leave no loop of intestine between the future opening and the duodenum ; the nearer that the opening can be placed to the fixed part of the latter the better.

An assistant with both hands grasping the stomach makes its posterior wall project towards the loop of jejunum. The surgeon now makes a straight incision through the outer coats of both viscera. This incision should be about one and a half to two inches long, and marks the size of the opening to be made in stomach and jejunum (*see* Fig. 60). The suturing is then carried out exactly in the manner described on page 209. When the stomach is opened it is well to explore its interior carefully with the finger in order to ascertain the position and size of the ulcer, etc. It is usually easy thus to reach the pylorus, and in some cases an ulcer may be found in the duodenum beyond the pyloric ring.

No mention has been made in the preceding description of the use of clamps. It is, however, certain that they facilitate the bringing of stomach and jejunum together, and prevent the escape of their contents when the two viscera are opened.

The operation can be done in less time and more easily if they are used; on the other hand, the surgeon cannot explore the interior of the stomach whilst the clamp is applied to it. We will assume that he is satisfied from the examination of its external surface that an ulcer or growth is present, and will note the special points with regard to the use of the clamps. Their employment makes the work of the assistant much lighter, as he is not required to hold the stomach against the intestine during the suturing. In fact, if the surgeon is short-handed at the time of the operation, clamps are invaluable.

The transverse colon is brought out of the wound and turned upwards; a good aperture is made in the meso-colon, taking care not to divide any vessels. A pouch of the posterior wall of the stomach is now drawn through this aperture, as near the pylorus and greater curvature as is convenient. One pair of clamps is made to grasp the base of the pouch from side to side. The first loop of jejunum, as near as possible to the fixed portion of duodenum, is also seized in another clamp. The two pairs of clamps are placed parallel and close together, so that stomach and jejunum are in apposition. The suturing is now carried out in the manner already described (page 209). The first continuous suture involves only the outer coats of the two viscera. A linear incision of two inches is made into the lumen of each, any superfluous and protruding mucous membrane being cut away with scissors. A second line of continuous suture is carried all round the opening; it traverses all the coats. Finally the encircling outer suture is completed in front of the opening and the clamps are removed from both stomach and intestine. If thought desirable a few Lembert's sutures are added, especially at either end.

Finally, the meso-colon is fixed at the margin of its aperture to the stomach wall by three or four sutures. Mr. Moynihan recommends that the meso-colon should be sewn to the jejunum rather than to the stomach, but we see no advantage in this procedure.

It may be noted that if clamps are employed, the surgeon

cannot tell whether any artery in the stomach wall has been divided or not; he trusts entirely to the pressure of his suture to prevent hæmorrhage. Although this pressure usually suffices, cases of serious and even fatal hæmorrhage after gastro-jejunostomy have now and then occurred.

After-treatment.—The patient should be nursed throughout with the upper part of the body raised; this can easily be arranged with pillows or by the head end of the mattress being slung up. The object is to prevent any chance of regurgitation of bile-containing fluids from the intestine into the stomach, where they would excite vomiting. For the first twenty-four hours it is best to give nutrient enemata, and nothing by the mouth except sips of water. At the end of the first day small quantities of milk may be given at frequent intervals, and if no sickness or discomfort ensues the quantity is soon increased. This is followed by eggs and milk or custard, until by the fourth day pounded fish, etc., is reached. The bowels are kept open by enemata. In most cases recovery is remarkably rapid, and if the patient has been much reduced previous to the operation, a remarkable gain in weight is the rule, sometimes two or three stones in a few months. Such rapid improvement is most common where the operation has been done for pyloric obstruction.

Comments on and Modifications of the Operation.—At first the anterior method was alone used, but posterior gastro-jejunostomy has come more and more into favour, and by some surgeons is always employed. The reasons given for the preference of the posterior method are (1) the opening is lower down in the stomach; (2) the commencement of the jejunum is opened instead of a part of the gut several inches from this point: hence regurgitation is less common, and the stomach evacuates itself more readily; (3) there can be no interference with the transverse colon by the jejunal loop, and no risk therefore of intestinal obstruction.

On the other hand, anterior gastro-jejunostomy has given excellent results in many cases, and it is somewhat the easier

to perform. Professor Kocher still advocates it in preference to the posterior method.

The question is hardly settled yet, but on the whole the posterior method is to be advised, whenever practicable. It is not necessary to discuss the use of Murphy's button in performing gastro-jejunostomy, since, in the opinion of most surgeons now this method should be abandoned, for the following reasons:

Suturing has given a larger percentage of recoveries, it leaves no foreign body behind which may perhaps remain in the stomach there is little or no tendency for the opening to contract (this has been repeatedly observed with the button) and many surgeons, after a trial of the other method, have returned to simple suturing. The rapidity with which the latter can be performed largely depends on practice and the use of the continuous suture instead of interrupted stitches

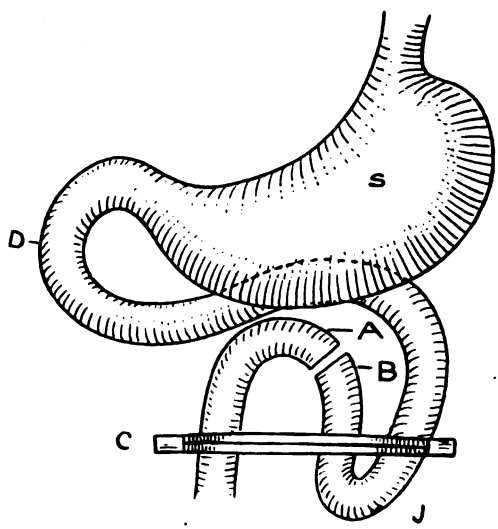

FIG. 63.—ROUX'S Y METHOD OF GASTRO-JEJUNOSTOMY.

C, Clamp holding loop of J, the jejunum, which is then completely divided into proximal (B) and distal portion (A). For completion of operation see next figure.

In some of the earlier cases it is recorded that two, three, or even more hours were taken. A surgeon with experience of the operation need rarely spend an hour over the operation from the first step to the last.

Many elaborate modifications have been practised with the view of preventing regurgitation from the intestine into the stomach. Of these the Y method of Roux, illustrated by Figs 63 and 64, may be taken as an example. It involves complete division of a loop of jejunum, implantation of one end into the

stomach and of the other into the side of the jejunum. Some surgeons bring up a loop of jejunum, make the communication between it and the stomach, and in addition a lateral anastomosis between the two sides of the loop (afferent and efferent portions). We believe that the simplest method gives the best result, and the fear of a vicious circle being established is ground-

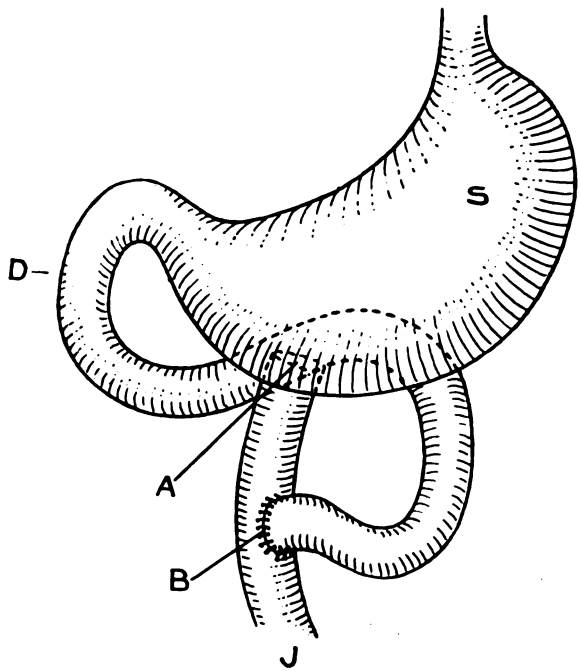

FIG. 64.—COMPLETION OF ROUX'S OPERATION.
The distal portion of jejunum (A) is implanted into the back of the stomach (S), whilst the proximal portion (B) is implanted into the side of the former.

less provided that the surgeon is careful to join the very commencement of the jejunum to the stomach in the manner which has been described.

Prof. Kocher, in 1903, suggested an interesting modification with the view of preventing return of bile, etc., into the stomach after gastro-jejunostomy. In several cases he has divided the peritoneum above and to the right of the

first part of the duodenum, and so been able to push inwards the latter sufficiently to establish the opening between the stomach and the duodenum above the orifice of the bile duct. The method is for obvious reasons hardly likely to be applicable to many cases of gastric cancer or ulcer.

The very elaborate plastic operation on the pylorus devised by Finney, an American surgeon, appears to us hardly to require description here.

The chief causes of mortality directly following gastro-jejunostomy are :—

1. Hæmorrhage into the stomach. This has occasionally followed both suturing and the use of Murphy's button. To prevent this, if any vessel of unusual size is cut across during the operation it should certainly be tied with silk.
2. Collapse and exhaustion. This may be due to the operation having been postponed too long, or to its being too protracted. Strychnia injections and giving nourishment by the mouth as soon as possible are the best means of combating it.
3. Peritonitis. This is nearly always due to leakage at the site of the orifice, and is certainly more apt to occur when Murphy's button has been employed.
4. Kinking of the gut.
5. Persistent vomiting. Elevation of the trunk and washing out the stomach with warm water should be employed if sickness comes on.

Mortality and After-results of Gastro-jejunostomy.—When performed for carcinomatous stricture of the pylorus the death-rate of the operation is naturally higher than when it is done for chronic ulcer. In the latter cases too, the prognosis will be more grave if severe hæmatemesis has weakened the vital powers of the patient.

With regard to cancer of the stomach, so much depends on the extent of the growth and other circumstances that it is useless to assign an exact percentage of deaths to the operation.

but it may be safely said that the danger of it lies rather in the condition for which it is done than in the operation as such.

When performed for non-malignant stenosis or to give rest to a simple ulcer, the mortality is certainly slight. Our own experience would put it well under 10 per cent.

Much will depend upon due selection of cases, and something on whether they are drawn chiefly from hospital or private sources. The personal skill of the operator derived from long experience is an important factor. Mayo Robson (*Med.-Chir. Trans.*, 1906) put the mortality at only 5 per cent. On the other hand, in Cohn's experience the mortality was 8.5 per cent., in Czerny's 10 per cent., in Chlumsky's as high as 20 per cent.

As regards the after-results, there are few operations that have given more complete success than gastro-jejunostomy in suitable cases—*e.g.* simple pyloric stenosis, extensive chronic ulcer and its complications. The patient, after a few weeks or months have elapsed, is as a rule restored to perfect health. When performed for duodenal ulcer the result is equally satisfactory. It may be noted that in the latter case Moynihan recommends that the ulcer of the duodenum should be infolded by a few Lembert's sutures in addition to the performance of gastro-jejunostomy.

In conclusion, a word of warning may be given. Gastro-jejunostomy has not unfrequently been performed without just cause. For chronic gastric catarrh and the like the operation will only prove a disappointment.

7. OPERATION FOR GASTRIC ULCER AND ITS RESULTS

Circumstances of the Operation. — The chief indication for operation in cases of simple gastric ulcer is the occurrence of perforation with the escape of stomach contents into the peritoneal cavity. This will therefore be considered first. As soon as it is recognised that such perforation has occurred the abdomen should be opened in the middle line above the umbilicus, with the twofold object of cleansing the peritoneum and sewing up the aperture in the stomach. The less the delay the greater

will be the chance of recovery. This is well brought out by the statistics given by Robson and Moynihan ("Diseases of the Stomach," 1902, page 161). When the operation was undertaken within twelve hours of the probable onset of perforation, about three out of four cases recovered; between twelve and twenty-four hours, only one in three lived; whilst the mortality of those operated on thirty-six to forty-eight hours after perforation rose to 100 per cent. Much will depend, however, on the degree of irritation produced by the extravasated fluid: in some cases localised peritonitis shuts off the mischief, and an operation which consists in the free drainage of a subdiaphragmatic abscess may be successful many days after the actual perforation. On the other hand, if the stomach is full of food and digestion is in active progress when the gastric ulcer gives way, an intense general peritonitis may be set up and be accompanied with such a degree of shock that the case is hopeless from the first.

It may be noted that rupture of a pyo-salpinx, or the bursting of an abscess which had been localised around the vermiform appendix, may give rise to the same symptoms as those of perforation of a gastric ulcer. This is of importance, since in the two former conditions the surgeon should explore below the umbilicus, in the latter the incision is made above. If the history can be obtained of prolonged dyspepsia and persistent epigastric pain (worse after meals), the probabilities are in favour of gastric ulcer. Hæmatemesis is a most uncertain guide, as in many cases of gastric ulcer there is no history of its occurrence. Abnormal resonance over the liver is present in about 50 per cent. of the cases of gastric perforation. The patient should be given the chance afforded by operation, unless when seen by the surgeon she is moribund from heart failure, or unless, with the lapse of time, general peritonitis has led to extreme abdominal distension. Before operating, the shock should be combated by injections of strychnia, by enemata of brandy-and-water, hot-water bottles and blankets, etc. It should not be forgotten that after the first severe symptoms the patient may rally and a

deceptive lull of some hours' or even days' duration occur. This is the very time for operation, and in no way a reason for its postponement.

Steps of the Operation.—The skin having been cleansed with an alcoholic solution of an antiseptic as thoroughly as time will allow, a free incision is made in the middle line. Thin fluid mixed with flakes of lymph (which form with extraordinary rapidity) or with particles of food will probably escape as soon as the peritoneum is incised. Stitch retractors or pressure forceps are used to hold the edges of the wound forward, whilst the operator with a large soft sponge rapidly clears away all extravasated fluid about the stomach, and brings the latter into view. It may be necessary to break down adhesions between the stomach and liver, and to keep the latter organ out of the way by sponge pressure or the hand of an assistant. In the same way coils of intestine which tend to protrude should be kept aside by flat sponges or gauze-pads. It is fortunate that the common site for perforation is one of the most accessible parts of the stomach. In 60 or 70 per cent. of the cases the opening will be found *on the anterior wall near the lesser curvature* and nearer the pyloric than the cardiac end. The hole may be very small, and usually the stomach wall for some distance around it is thickened and hard.

If the stomach is fairly full it should be emptied by passing a rubber tube down the œsophagus and gently siphoning its fluid contents away. Moynihan lays stress on the value of this procedure.

If the perforation is situated under the left side of the diaphragm it may be necessary to cut across the rectus muscle in order to expose it. In this case the superior epigastric artery should be at once clamped. A perforation close to the cardiac end is extremely difficult to expose. Supposing the surgeon has examined the whole of the anterior surface without finding the ulcer, and yet the nature of the extravasation makes it certain that the alimentary canal is leaking high up, he should carefully examine the duodenum, and so far as is possible the

posterior surface of the stomach. A perforation of the duodenum should be dealt with in the same manner as one of the stomach. But few cases of suture of perforations on the posterior wall have been recorded. In one case under my (J. H.'s) care the extravasated fluid was noticed to be oozing from the foramen of Winslow—*i.e.* out of the lesser sac; an aperture was made in the lesser omentum, and a perforation found opposite the pancreas. The assistant's hand being used to turn the stomach round, and so expose the ulcer, the latter was excised, a row of sutures was inserted, and the patient made a good recovery. It has been recommended that the posterior surface should be reached through an aperture made in the gastro-colic omentum *i.e.* from below, but experience in the case mentioned leads us to advise the upper route through the lesser omentum.

It may be that the patient's condition does not allow of time being spent over suturing the stomach wall, or the latter may be so friable that any stitches inserted at once cut out but generally a row of Lembert's or other sutures can be safely introduced. If the ulcer is small, it may be excised with advantage. Occasionally a piece of omentum (or, in a successful case reported by Mr. Heaton, a piece of reflected falciform ligament) can be sewn down over the perforation when the latter cannot itself be closed by stitches.

The next step is to cleanse the peritoneal cavity, and this is best done by large moist sponges. Particular attention should be paid to certain regions, namely—

The cavity of the pelvis.

Each renal fossa.

The subdiaphragmatic spaces on either side.

The subdiaphragmatic spaces are especially liable to be overlooked. It will be understood that to reach the pelvis the wound may have to be considerably enlarged, and some even advocate that the intestines should be drawn outside the abdomen in order to cleanse them. This, however, involves increased shock and further time, and it is important that the surgeon should work with all possible rapidity.

Free handling of the intestines is an important cause of shock. All loose foreign material, septic fluid, etc., should be cleared away by sponging, but no attempt should be made to detach adherent flakes and layers of lymph from the intestinal wall in these cases. Such detachment is both useless and harmful.

Irrigation with warm water is recommended by some. Surgical opinion has on the whole tended to discard irrigation, because it is prone to carry septic material into regions not yet invaded. Local and limited irrigation, however, made with a saturated sponge, is often useful. (For a discussion on the general question *see* page 107.)

It is a good plan to pass a small sterile sponge on a holder into any recesses amongst the viscera to ascertain by inspection of it whether the stomach contents have invaded them or not. If the sponge is not soiled such recesses should be left severely alone in the peritoneal toilette.

Before closing the abdomen the surgeon should provide for drainage of the stomach region by tubes and gauze drains, particularly of the left hypochondrium. It is often advisable to drain each loin as well as Douglas's pouch by tubes brought out through counter-openings. It is almost always necessary to drain Douglas's pouch by a suprapubic drain, which can be introduced through a puncture separate from the main wound.

Should gastro-jejunostomy be performed at the same time? Although it is true that some cases have recovered after this course has been adopted we think that it is not to be recommended. The condition of the patient with perforation of the stomach is such that any prolongation of the operation is to be avoided. If the patient recovers the question of gastro-jejunostomy may be considered later; in many cases it will not be found necessary.

After-treatment.—The shock of the operation is best met by free intravenous or rectal injections of saline infusion and strychnia. The patient's pelvis should be raised and the head kept low. For some days after the operation feeding with peptonised milk and meat-juice should be carried out *per rectum*. If the perforation has not been closed by sutures, or if it leaks

subsequently, the region of the stomach should be gently irrigated every day, and a two-way drainage tube is convenient for the purpose. Occasionally a secondary abscess develops high up under the diaphragm, and may need a posterior opening.

Proportion of Recoveries.—It is probable that of all the cases operated on, not more than 30 per cent. recover, though it would be easy to quote more favourable statistics. As already mentioned, the earlier the time at which the operation is undertaken the greater is the patient's chance. The mortality attending perforation of duodenal ulcer is even higher than that of gastric perforation, and comparatively few cases have been operated on successfully. For a record of cases, see Mr. Moynihan's paper, *Lancet*, December 14th, 1901.

Operation for Gastric Ulcer which has not Perforated.—In view of the many complications following gastric ulcer, the considerable mortality due to hæmatemesis from the ulcer (about 10 per cent. of all cases), and the still higher mortality following perforation from this cause, it is reasonable to expect that early operation will be more resorted to. The object of such early operation is a direct and curative one, and is accomplished either by (1) excision of the ulcerated part of the stomach wall, followed by careful suturing of the wound; (2) ligature of the bleeding point after opening the stomach; or (3) gastro-jejunostomy to give rest to the stomach and promote healing of the ulcer.

Gastro-jejunostomy has been attended with considerable success in the treatment of cases of persistent or recurrent hæmatemesis.

It should be noted that in some cases of severe or even fatal hæmatemesis which have been diagnosed as gastric ulcer no appreciable ulcer has been found after a thorough search, either during operation or at the post-mortem examination. These cases are, however, quite the exception.

The cases of hæmatemesis most favourable for operation are those of repeated hæmorrhage of small amount, which produce

anæmia and asthenia. Ulcers, whether partially healed or not, which are situated near the pylorus tend to cause narrowing of this part, and lead to gastric stasis and dilatation. In both these forms of stomach disease gastro-jejunostomy is, as a rule, most successful. Operation should, however, be avoided in cases of simple atonic dilatation of the stomach as well as on patients with neurasthenic conditions (apart from organic disease).

Moreover, gastro-jejunostomy performed for simple ulcer without pyloric obstruction is sometimes unsuccessful. The majority of such cases can be cured by complete rest in bed with careful dieting and medical treatment. The operation has been too often performed in unsuitable cases, such as those of chronic dyspepsia without ulcer, in which only disappointment and discredit can result from it.

Excision of the Ulcer in place of Gastro-jejunostomy.—As already noted, this procedure is not in favour with most surgeons. But Rydigier, for example, urges that resection is on the whole the most rational operation of the two, and that with special care in the technique it is quite as safe. In our opinion, excision of the ulcer is often impossible, or is attended with undue risk.

Operation for Hæmatemesis.—If the surgeon aims at dealing directly with the bleeding ulcer, an incision is made in the long axis of the stomach through its anterior wall, the viscus being brought as far as possible into the wound. The edges of the stomach wound being held open, the interior is carefully sponged out, and its mucous membrane inspected. It may be that a single well-defined ulcer is found: in this case complete excision may be performed, unless it be situated on the posterior wall. If excision be impossible, gastro-jejunostomy is frequently advisable. The bleeding, however, sometimes proceeds from a number of minute vessels, which may be secured separately by fine silk ligatures applied to each bleeding spot as the mucous membrane is made to bulge forwards. In any case, whether the bleeding spot can be directly dealt with or not, it is advisable to perform a gastro-enterostomy. Moynihan (*Brit. Med. Journ.*, April 8th, 1905), out of a total of twenty-two operations for

hæmatemesis, performed gastro-jejunostomy in twenty-one. In three of these cases the ulcer was also excised. It should be noted, apart from the difficulty often met with in finding the source of the bleeding, that gastric ulcers are frequently multiple or complicated by such adhesions (especially to pancreas or liver), that their excision would be most dangerous. There is no question that simple gastro-jejunostomy is the safest form of operation for chronic ulcer of the stomach, whether attended by hæmatemesis or not, and that in a considerable proportion of cases it is followed by cure.

DUODENOSTOMY AND JEJUNOSTOMY

These operations consist, as the names imply, in the establishing in the duodenum or jejunum of an artificial opening or stoma, through which food can be introduced. The measures have been carried out in cases of stenosis of the pylorus of various kinds.

Duodenostomy was first performed by Langenbüch in 1879. The operation has been carried out in two stages. In one the bowel is attached to the wound in the parietes; in the other it is opened.

The operation has been performed several times, but in few instances has the patient survived more than a few days.

In jejunostomy the artificial opening is made lower down in the intestine. This operation has not been performed many times, but it has been attended by some degree of success. It is claimed for this measure—when compared with gastro-enterostomy or pylorectomy—that it is very simple, that it is readily carried out, and that it may be very quickly performed. There is no risk of extravasation from the stomach, or of kinking of the bowel; the colon cannot be compressed, as has been the case sometimes in gastro-enterostomy; and more complete rest is given to the malignant growth.

The stomach is, however, excluded from the digestive process, and unless the artificial opening be made quite high up in the jejunum the probability of gradual starvation is considerable. The stomach is not relieved, and no food can be taken by the mouth.

Moreover, the fluid in the duodenum and upper jejunum is very irritating to the skin, and it is more difficult to prevent it from escaping than in the case of gastrostomy.

For these reasons the operations are hardly worth describing

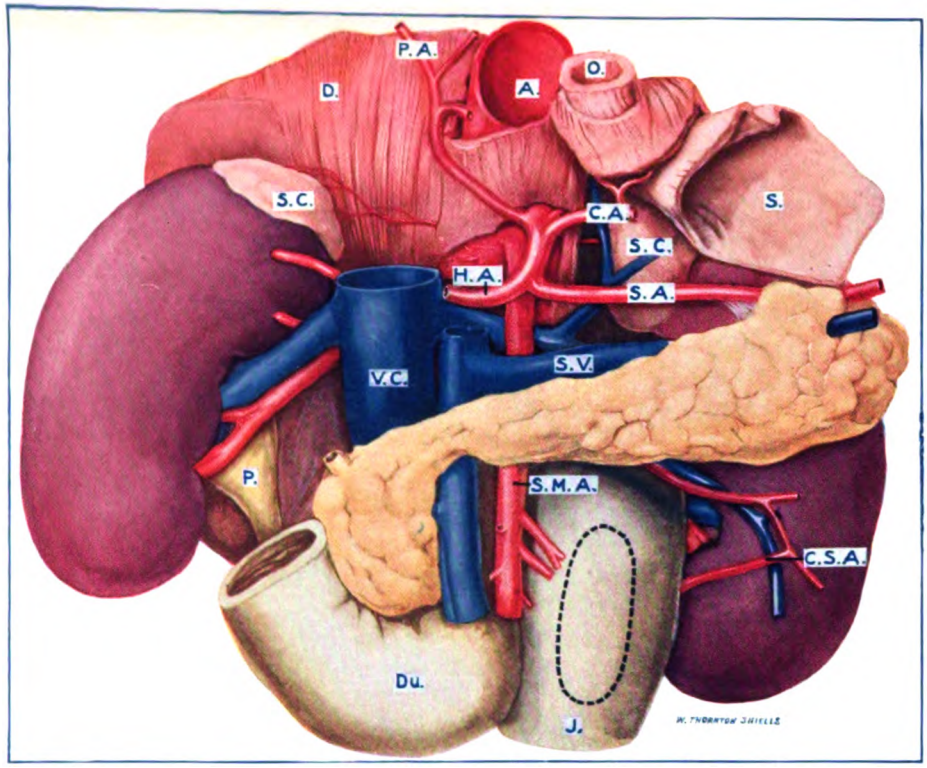

PLATE XI.—PANCREAS, DUODENUM, KIDNEYS, ETC., SEEN FROM THE FRONT.

(From a Dissection in the Museum of the Royal College of Surgeons.)

A., AORTA. O., ŒSOPHAGUS. S., CARDIAC PORTION OF STOMACH. D., DIAPHRAGM. S.C., RIGHT SUPRARENAL BODY. Du., THIRD PORTION OF THE DUODENUM. J., COMMENCEMENT OF THE JEJUNUM (THE DOTTED AREA INDICATES THE BEST POSITION FOR THE OPENING IN GASTRO-JEJUNOSTOMY). V.C., VENA CAVA. S.V., SPLENIC VEIN. P.A., PHRENIC ARTERY. C.A., CORONARY ARTERY OF STOMACH. S.A., SPLENIC ARTERY. S.M.A., SUPERIOR MESENTERIC ARTERY. H.A., HEPATIC ARTERY. C.S.A., COLICA SINISTRA ARTERY. P., PELVIS OF RIGHT URETER.

(NOTE.—Nearly the whole of the stomach and the upper part of the head of the pancreas have been cut away.)

CHAPTER IV

OPERATIONS ON THE PANCREAS

Preliminary Considerations.—The pancreas (Plate XI.) is not only richly supplied with blood-vessels, it is in close relation with a remarkable number of large arteries and veins. No other viscus compares with it in this respect. Resting immediately upon the vena cava and aorta, it is tunnelled vertically by the portal vein and superior mesenteric artery. The splenic artery and vein are closely applied to its upper border. Many branches of these main vessels run on its surface or traverse its substance. Hence a cyst of the pancreas is apt to present large arteries and veins in its wall which require careful avoidance during the operation of drainage. Hence also the frequency with which hæmorrhage complicates suppuration or inflammation of the gland itself.

The pancreas extends obliquely across the spine in front of the first and second lumbar vertebræ, from the hollow of the duodenum to the spleen. Its most prominent part, concealed by stomach and transverse colon, is that part of the body to the left of the head. This part, which may be detected in thin subjects through the abdominal wall, is pushed forward by the spine. The pancreas lies more deeply as one approaches the tail of the organ, and even if this part is enlarged by disease or tumour it may be impossible to feel through the abdominal wall.

The deep position in the left loin of the pancreatic tail should be noted with regard to possible drainage of a pancreatic cyst in this region. It is, however, unlikely that a pancreatic tumour would be approached from this direction before its nature and relations were ascertained through an abdominal section made in front. As an adjunct to anterior drainage, an opening in the left loin has frequently been employed with success. So im-

portant are the posterior relations of the pancreas on the right side that it would seem impracticable to drain a cyst of the organ in the right loin. Nevertheless in a few cases this has been done.

The pancreas rests at either end on the right and the left kidney. An important relation of the pancreas is to the lesser sac of peritoneum which covers the whole of its anterior surface. Many "pancreatic cysts" have been proved to develop really in the lesser sac (Jordan Lloyd), and hence their fluid contents may possess but little digestive properties. Whether a cyst has developed in the gland itself or in the lesser peritoneal sac it is certain to push forwards and to adhere closely to the stomach and colon, which will probably be flattened and displaced by the cyst.

There is obvious risk, in opening a cyst of the pancreas or lesser sac, that the displaced and adherent stomach or colon may be accidentally wounded. One surgeon has recorded his experience of drainage of a pancreatic cyst *through* both gastric walls, and has seriously proposed this method for occasional use. His imitators, if any, will be unintentional.

Exploration of the Pancreas.—When the abdomen has been opened the front of the pancreas can be reached by one of three routes:—

1. Through the gastro-hepatic omentum above the stomach.
2. Between stomach and transverse colon through the gastro-colic omentum.
3. Through the meso-colon, as in gastro-jejunostomy.

For simple exploration of the pancreas it is not important which route is taken so long as the vessels in the respective peritoneal folds are avoided, but for purposes of drainage the second route is the one to be chosen. In the case of cysts the surgeon will choose either route 1 or route 2, according to the direction in which the cyst bulges the most.

Apart from the danger of wounding large vessels in incising the pancreas, this organ must be treated with the greatest respect by the surgeon. Even a small incision into its parenchyma may

involve the escape of most irritating and powerful fluid into the peritoneum, fat-necrosis being another special complication of wounds of the pancreas.

It is impossible to suture the pancreas so as to be sure of good union, and hence drainage should be provided for invariably if the surgeon has been obliged to incise this organ.

Operative Treatment of Acute Pancreatitis.—The causes of acute inflammation of the pancreas are still in doubt. The only one clearly established is a blocking of the ampulla of Vater by a small stone which dams back bile into the pancreatic duct. In many cases, however, no calculi are present. The symptoms are as a rule of extreme gravity and rapid onset; they may simulate those of intestinal obstruction or perforation of a gastric or duodenal ulcer. Fitz observes: "Acute pancreatitis is to be suspected when a previously healthy person or sufferer from occasional attacks of indigestion is suddenly seized with violent pain in the epigastrium, followed by vomiting and collapse, and, in the course of twenty-four hours, by a circumscribed epigastric swelling, tympanitic or resistant, with slight rise of temperature." Moynihan noted in two cases that the general surface of the body was livid, cold and damp—evidence of the extreme collapse of the patient. Halsted also lays stress upon the peculiar lividity or cyanosis of the abdominal wall. Acute pancreatitis is usually accompanied by hæmorrhage into the gland, which soon escapes into the peritoneal cavity. Owing to the action of the pancreatic fluid, the fat in the neighbourhood undergoes necrosis, and sodden sloughs may be found mixed with blood-clot. Occasionally (as in one case we drained with success) an acute localised abscess without hæmorrhage is met with in the substance of the pancreas, the pus being retained under high tension. Whether this be the case, or whether hæmorrhage with sloughing or necrosis is present, the provision of free drainage probably gives the best chance of recovery. At the same time operation whilst severe collapse is present is almost certain to prove fatal, and the recoveries from acute septic pancreatitis under any circumstances have been very few. Thus Dr. Halsted (*Johns Hopkins Bull.*, June, 1901)

noted that "of twenty-five cases of acute hæmorrhagic pancreatitis operated upon, only two have recovered, a case operated upon by me eleven years ago, and Halen's case recently reported." At the London Hospital of late years twelve cases of hæmorrhagic and phlegmonous pancreatitis have been operated upon by abdominal section, all with fatal ending.

Mickulicz in 1903 collected records which would give a far more favourable view of the results of operation. Out of seventy-five cases of operation for acute pancreatitis no less than twenty-nine patients recovered, *i.e.* 35 per cent. It must be remembered that this list was drawn up chiefly from isolated records in print of successful cases, and the following figures from the London Hospital records during the years 1902 to 1907 give probably a more truthful picture:—Number of cases of acute hæmorrhagic, or suppurative pancreatitis, fifteen—ten males, five females. Of fourteen operated on, two only recovered.

The prognosis after operation for subacute pancreatitis, particularly where a localised abscess has formed, is more favourable. Three out of five cases operated on by Mayo Robson recovered (*Brit. Med. Journ.*, May 11th, 1901).

Details of the Operation, etc.—The collapse of the patient must be overcome first by giving morphia hypodermically to relieve the intense pain always present, and by free administration of brandy in warm saline injections *per rectum*, etc. Ether should be the anæsthetic unless a local one (eucaine) is preferred. A sand-bag or pillow is placed behind the back. The abdomen is rapidly opened in or to the right of the middle line above the umbilicus. Any blood-stained fluid found is mopped out. Then the stomach is drawn upwards. If distended it should be washed out and emptied through an œsophageal tube. The swollen pancreas will probably be found to protrude forwards beneath the gastro-colic omentum, in which hæmorrhages or patches of necrosed fat are present. A small incision through the omentum is made, directly over the swollen gland, taking care to avoid the transverse colon and any large blood-vessels in the omentum. The surrounding area is guarded by moist sterile swabs or towels

(with the usual precautions against their possible loss). The opening in the omentum is stretched and the pancreas itself examined. If an abscess or fluctuating patch is found, it is incised, the pus or broken-down tissue sponged away, and a large double or two-way drainage tube inserted. The tube is secured to the anterior abdominal wall by two sutures, and a strip of sterile gauze is lightly packed round the tube down to the gland. As much of the abdominal wound as is convenient is then sewn up, of course leaving one end of the gauze projecting. The fluid that will subsequently escape through the tube is apt to irritate the skin severely; hence the tube should be a long one projecting well over a mass of soft absorbent dressing, which is frequently changed. Or it may be possible to siphon the fluid off, so as not to come in contact with the skin.

Most of the cases have been drained through the anterior incision above described, but Mayo Robson suggests that when possible a free vertical incision in the left costo-vertebral angle should be employed to reach the pancreas, after the diagnosis has been made from in front. Certainly the dependent drainage thus provided is an advantage, though the difficulty of the operation is perhaps increased together with the danger of protracting it.

After-treatment.—In the after-treatment the first point is to combat the shock by rectal infusion with stimulants, strychnia hypodermically, etc. Calomel with salol should be given for several days, unless diarrhœa supervene, when opium may be necessary. If a two-way tube has been secured in the wound, the abscess may be gently washed out through it until clear pancreatic secretion alone comes away. The gauze round the tube should not be removed until several days have elapsed. The pancreatic fistula may be many weeks in closing. "It will be necessary to keep a sharp look-out for further collections of pus, and for subphrenic abscess or empyema, which on recognition will need treatment" (Mayo Robson).

Operative Treatment of Chronic Pancreatitis.—Mr. Mayo Robson, Prof. Körte, Mr. Gilbert Barling, and other surgeons

have abundantly demonstrated by clinical evidence the relation between gall-stones and chronic interstitial inflammation of the pancreas. It is especially in these cases, where, for instance, small gall-stones have lodged in the ampullary end of the common bile duct, that operation for their removal, including temporary diversion of the flow of bile by cholecystotomy, will probably lead to "cure" of the pancreatic condition.

There are, however, many other causes of chronic pancreatitis than cholelithiasis, which it is estimated is only present in one out of three or four cases. One of these causes is the existence of pancreatic calculi, single or multiple. Cholecystotomy is useless for this condition, the rational treatment being to remove the stones from the pancreas itself. When there is but one stone, this has been effected with success in several cases, either by direct incision through the gland into the main pancreatic duct, or by incision of the vertical part of the duodenum and exploration through the ampulla of Vater.

But where pancreatic lithiasis with widely scattered stones is present, the difficulties are apparently insuperable. The following case under one of us (J. H.) illustrates this:—

An elderly woman came under treatment for a tumour in the pancreatic region attended with severe intermittent pain and loss of strength, etc. The tumour proved to be a multilocular cyst in the pancreas. It was drained from in front, and many small white calculi, very hard and sharp-pointed, were removed. The fistula would not close, and the probe giving evidence of a calculus deep down in the pancreatic head, a second operation was performed many months after the first one. An incision was made through the right rectus over the vertical duodenum, the latter was incised and the papillary opening of the bile and pancreatic ducts was enlarged. Thorough exploration of the main pancreatic duct aided by the finger in the old sinus was not successful in finding more than one or two small stones. The duodenal wound was sewn up with a double row of sutures, and united well. It was hoped that the enlargement of the pancreatic duct's opening might lead to improvement, but this was not the case, and the patient died a few months later. The pancreas was found to be

entirely converted into two irregular cysts with hard walls in which were embedded a number of small stones and calcareous plates. One of the cysts had opened into the stomach shortly before death.

From the evidence of Mayo Robson's cases it appears that benefit has followed cholecystotomy sometimes, although no calculi of either kind, biliary or pancreatic, have been discovered. So slight is the risk of temporary drainage of the gall-bladder that the surgeon is probably justified in employing it in any case where chronic pancreatitis has been found by exploration. At the same time it should be remembered that the symptoms have entirely disappeared when nothing more has been done than simple exploration followed by closure of the abdominal wound. Of this result Mr. Edmund Owen (*Brit. Med. Journ.*, 1902, vol. ii.) records two striking examples.

Further, there is good evidence to prove that chronic pancreatitis is not unfrequently recovered from without operation, doubtless in some cases from escape of a gall-stone into the intestine. It is asserted that it is liable to pass on into cancer, and certainly the diagnosis between the two is most difficult, and sometimes impossible at the time of operation.

In an ingenious paper founded on the post-mortem records of Guy's Hospital for forty years, Dr. Hale White (*Brit. Med. Journ.*, July 18th, 1903) seeks to prove that "chronic pancreatitis is excessively rarely a fatal disease, probably not being responsible for more than one or two out of nineteen thousand deaths, and certainly not being responsible for more than four."

It is desirable to refer briefly to the symptoms due to chronic pancreatitis before describing the operation for its relief. They are—(1) a tender firm tumour lying across the abdomen behind the stomach, (2) progressive loss of strength and weight, (3) paroxysmal attacks of pain in the epigastric region, radiating from right to left, and to the interscapular space, (4) presence of sugar in the urine, with or without peculiar crystals deposited on the application of Cammidge's test, (5) the presence of undigested muscle fibre or fat in the fæces.

None of these symptoms is, however, invariably present, and any of them may accompany malignant growth of the pancreas.

Details of the Operation, etc.—In nearly all the cases jaundice is present before operation. Those who believe in the efficacy of chloride of calcium in checking hæmorrhage under such conditions will administer drachm doses of it by mouth or rectum for three days or so before operation. We have not been able to confirm Mayo Robson's eulogy of this drug.

On the other hand, we attach much importance to preliminary injections of strychnia, and the judicious use of stimulants so as to prevent shock. The operation may involve extensive separation of adhesions in the solar plexus region, and is therefore likely to test severely the strength of a patient already much reduced. The actual steps of the operation have been already alluded to. They involve vertical incision just to the right of the median line, careful isolation of gall-bladder and stomach if adhesions are present, making a small opening in the gastro-colic or gastro-hepatic omentum, and examination of the front surface of the pancreas. The organ is found to be indurated, and perhaps enlarged. To determine whether these conditions mean chronic inflammation or new growth (cancer) may be very difficult, if not impossible. A high degree of jaundice or very marked wasting, if present, is in favour of the pancreatic enlargement being malignant. There are few diseases in which emaciation is so rapid as cancer of the pancreas. The presence of ascites and of large glands in the gastro-hepatic omentum or immediately in front of the spine are also signs of new growth of some diagnostic value.

In every case a careful examination by palpation is made of the gall-bladder and bile ducts—in particular of the lower portion of the common bile duct. Of course gall-stones may co-exist with malignant induration of the pancreas, but if a calculus can be felt in the lower portion of the common duct it is probably the cause of co-existing enlargement or induration of the pancreas. In such a case the duct should be opened either

above the duodenum or through its walls (*see* Choledochotomy, p. 166) and the stone extracted. Drainage of the duct is then advisable. In other cases where no calculi can be found in the common duct, but the gall-bladder is tense and distended, it is best to perform cholecystotomy. Even if the pancreatic enlargement be malignant, drainage of the gall-bladder may give some relief for a time. And, as Mayo Robson has shown by examples, a pancreatic lump which at the time of operation has been confidently diagnosed as cancerous may ultimately subside after cholecystotomy.

In cases of advanced and undoubted cancer, where, for example, secondary growths in or about the liver are found, cholecystotomy should, however, not be done as a rule. The patient's life is rarely protracted, and the biliary fistula may be a nuisance to him during the remaining weeks of his life.

It may naturally be asked why, in chronic pancreatitis with biliary obstruction, cholecystenterostomy should not be substituted for an external biliary fistula. The answer is that it has often been tried, but almost invariably with bad result. Infection of the gall-bladder and ducts from the intestine by the *Bacillus coli* is certain to result, whilst the drainage of bile may be unsatisfactory.

Operative treatment of pancreatic cysts consists, in the great majority of cases, in fixing the cyst-wall by sutures to the abdominal wound and then draining the cyst, which ultimately contracts and becomes obliterated. To this procedure has been given the uncouth name of "marsupialisation," the cyst with its anterior opening being compared to the abdominal pouch of the kangaroo.

The method has the disadvantage of being very tedious in many cases, a fistula remaining for months or even years. Were it possible to excise the cyst and to close the abdominal wound entirely, this would be a preferable method; but the fact that the cysts are usually in the very substance of the pancreas, adhering strongly to stomach or colon, etc., and with large veins and arteries in their walls, renders this impracticable. Only when

the cyst develops in the tail of the pancreas, and is more or less pedunculated, is complete excision practicable.

The following statistic of cases collected by J. Boeckel (Congrès de Chir., 1900) shows the relative frequency of simple drainage and excision, and the comparative risk of the two procedures :—

Drainage, etc., after fixation, 104 cases, 9 deaths (8·6 per cent.).
Excision of the cyst, 21 cases, 6 deaths (28 per cent.).

Of the nine fatal cases after drainage operation, four died immediately after it ; of the five others, two died from subsequent diabetes and two from carcinomatous degeneration of the cyst-wall.

Of the six fatal cases of excision, in four it was quite impossible to remove the whole cyst-wall.

Wölfler's figures, though published seven years later than Boeckel's, only confirm the comparative safety of drainage and the practical impossibility in most cases of excision of the cyst. Wölfler (*Präger. med. Woch.*, No. 2, 1907) quotes 131 cases of incision with drainage, the mortality being 5·3 per cent., whereas eighteen cases of attempted excision of the cyst resulted in five deaths.

The most favourable cases for drainage are those of simple cyst of the lesser peritoneal sac, the " pseudo-pancreatic " cyst. The most unfavourable are the multilocular cysts which burrow throughout the substance of the pancreas and contain multiple calculi and calcareous deposit in their walls. The latter form of cyst cannot be excised, nor can it be expected to become entirely obliterated by drainage.

It used to be said that no case of pancreatic cyst was ever diagnosed as such before operation, but this is no longer true. A large rounded tumour, median in position, and firmly fixed to the spine in the epigastric and umbilical regions, developing as a rule in adult life and often preceded by local injury, varying in size, and causing considerable pain as it grows—such are the signs which will lead to the diagnosis of pancreatic cyst.

It should be noted that aspiration, done for the purpose of

establishing the diagnosis, is most dangerous, and should never be undertaken. An open exploration is far safer.

Steps of the Operation.—The abdomen being opened through an incision just to the right of the median line, a careful exploration of the tumour is made, the position of the stomach and colon ascertained (the cyst usually bulges forwards behind both viscera, stretching them over its surface), and the extent to which the cyst reaches back into either loin should be made out. If it bulges well into the left loin, for example, the operator may decide to drain it posteriorly as well as from the front; if it does not do so, he should be content with anterior drainage. If the cyst has formed rapidly there may be many inflammatory adhesions around it, and care should be taken in dealing with these lest severe hæmorrhage be started. Large gauze swabs, each with a long tape attached to it, are packed around the tumour, leaving the most projecting part exposed. Carefully avoiding both stomach and colon, as well as any large vessels in the cyst-wall, the operator pushes a large-sized aspirator needle into the cyst. The point of puncture should as a rule lie between the colon and stomach, the needle traversing the meso-colon. The cannula is apt to be blocked by pancreatic *débris* in the cyst, but enough fluid will be drawn off to relieve the tension, and to enable the cyst-wall to be drawn forwards for suture to the abdominal wall. If anterior drainage alone is to be carried out (and this is done in the great majority of cases), a long drainage tube, two-thirds of an inch to one inch in diameter, is inserted through an opening in the cyst-wall which is made at the site of aspiration. The tube should block the opening. Before this is done it is well to clamp the aspiration opening and to secure the

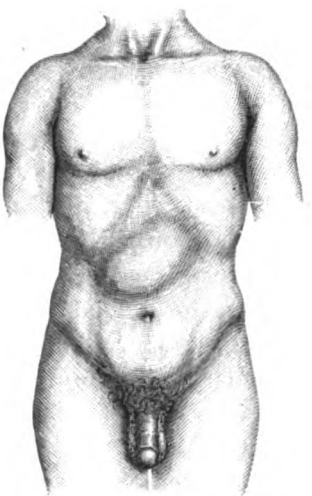

FIG. 65.—PANCREATIC CYST IN A MAN AGED 50.

cyst-wall by fine sutures to the edge of abdominal wall (peritoneum and transversalis aponeurosis and fascia). All swabs that have been inserted must, of course, be removed.

The best form of drainage tube in our opinion is the two-way variety—which allows of subsequent washing out of the cyst. Whether a double or single tube is used, it should be long enough to project some few feet beyond the dressings, and thus to keep the irritating secretion of the pancreas away from the skin.

If posterior drainage is adopted—and it is certainly an advantage—the procedure will vary slightly from that described above. The cyst is more freely opened in front, sufficient to allow the operator's fingers to enter. By digital pressure from inside the cyst below the last left rib a suitable point is made out for the posterior incision.

The escape of fluid is very free and difficult to control, and care must be taken lest it infect the peritoneal cavity. The patient is turned slightly on to his side. A good-sized drainage tube being inserted into the cyst and brought out in the loin, a second one, which may be smaller, is fixed in the front wound by a purse-string suture through the cyst-wall.

A large dressing of moist gauze is applied over each wound. It is important to secure each tube by silkworm gut to the edge of the wound.

After-treatment and Possible Complications.—If posterior drainage has been carried out, the greater part of the fluid will escape through this tube, and in a few days' time the front one may be removed. This, however, should not be done until the dressings in front are almost dry. At first the cyst fluid is usually turbid, with coagula or sloughy lumps in it. It will probably have the properties of pancreatic juice to some slight extent, *i.e.* it will digest fatty and albuminous material, convert starch into sugar, etc. But as the fluid becomes clearer and more scanty, it has these properties in more marked degree, and may cause extreme irritation of the skin around the wound.

A soothing ointment, such as lanoline cream, should be applied from the first. At the same time the fluid should be

conveyed as far as possible away from the wound. Obviously, a long drainage tube can be more readily used through an anterior than a posterior opening. On the other hand, a dependent opening will probably lead to more rapid contraction of the cyst.

For a time the dressings will require to be frequently changed —the ointment being applied each time.

As the case progresses it is often advisable to wash the cyst out with weak sterilised iodine solution, but if irrigation be employed, care should be taken not to distend the cyst, for fear of rupture.

We have known one case end fatally a fortnight after operation, apparently from the cyst-wall giving way.

One complication at the time of operation deserves special note, namely, hæmorrhage from the cyst-wall.

In one case under my (J. H.'s) care furious bleeding started on making a small opening into the cyst—it was quite impossible to apply a ligature. A clamp forceps left on for a few days successfully controlled the bleeding, and the case did well.

CHAPTER V

OPERATIONS ON THE INTESTINES

Anatomical Points.—In the Hunterian Lectures, delivered at the Royal College of Surgeons in 1885, an account was given of the disposition of the intestines, which was founded upon the examination of one hundred fresh bodies. These bodies were all examined within twenty-four hours of death.

From the published account of these Lectures ("The Anatomy of the Intestinal Canal and Peritoneum in Man," by Sir F. Treves) the following points, bearing upon the surgery of the bowel, are abstracted :—

The average *length* of the small intestine is about twenty-three feet, and of the colon about four feet six inches.

There is no systematic *arrangement of the coils* of the small intestine. There is a disposition for the bowel to follow an irregularly curved course from left to right, but in the adult this disposition can never be relied upon. Such as it is, it may be expressed as follows. The gut, starting from the duodenum, will first occupy the contiguous parts of the left side of the epigastric and umbilical regions ; the coils then fill some part of the left hypochondriac and lumbar regions ; they now commonly descend into the pelvis, reappear in the left iliac quarter, and then occupy in order the hypogastric, lower umbilical, right lumbar, and right iliac regions. Before reaching the latter situation they usually descend again into the pelvis.

The coils most usually found in the pelvis belong to the lower ileum, and to the bowel between two points respectively six feet and twelve feet from the duodenum.

In examining a coil of protruded small intestine, the following points may be made use of to *distinguish jejunum from ileum.*

The jejunum is wider than the ileum, its coats are thicker and more vascular, and the valvulæ conniventes—as seen on holding the coil to the light—are large and well marked. These folds are absent in the lower ileum, while it is in that part of the canal that Peyer's patches are most distinct.

With regard to the *mesentery*, its upper or right layer is continuous with the under layer of the transverse meso-colon, and with the peritoneum that invests the ascending colon. Its lower or left layer joins with the serous membrane that encloses the descending colon, that forms the sigmoid mesentery, and that descends over the lumbo-sacral eminence into the pelvis.

The parietal attachment of the mesentery is liable to considerable variation. It commences at the end of the duodenum, just to the left of the spine, and thence follows an oblique line which runs downwards and to the right, crossing the great vessels, and ending in a somewhat uncertain manner in some part of the iliac fossa. The mesentery becomes elongated in hernia, and is liable to many congenital variations.

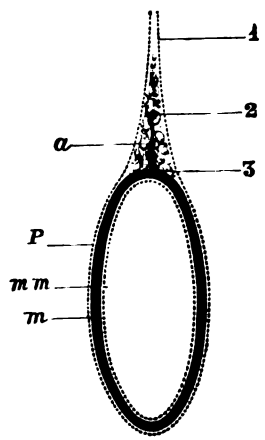

FIG. 66.—SECTION OF SMALL INTESTINE AND MESENTERY.

1, Mesentery; 2, Triangular space; 3, Base of triangle; *P*, Peritoneum; *m*, Muscular coat; *m m*, Mucous coat; *a*, Artery to bowel.

With regard to the visceral attachment of the mesentery, attention must be drawn to the excellent and practical investigations of the late Mr. Wm. Anderson ("MacCormac on Abdominal Section," London, 1887, pages 25 and 80):—"Owing to the divergence of the two layers of the mesentery as they approach the bowel, a portion of the circumference of the jejunum and ileum is destitute of serous investment. The separation of the laminæ of the mesentery begins at a distance of about two-thirds or three-fourths of an inch from the intestine, and leaves a triangular space, the base of which, averaging about five-sixteenths of an inch in width, is formed by the uncovered muscular

tunic. This interspace is occupied by fat, by the vessels and nerves of the gut, and by delicate fibres of connective tissue (Fig. 66).

"Unless this disposition of the peritoneum be taken into account, it is obvious that a suture applied in the manner of Lembert might fail to bring into contact the true wall of the intestine at the mesenteric attachment, and a leakage from the interior of the tube might take place into the interserous triangle and peritoneal cavity.

"The *disposition of the arteries* within the triangle is worthy of notice. The last row of anastomotic loops, from which arise the direct branches of supply, is placed much nearer to the intestinal wall in the lower than in the upper portion of the bowel, and towards the termination of the ileum commonly lies within one-third of an inch of the canal. From these loops are given off, at moderately regular intervals, straight vessels, which do not intercommunicate, but pass at once to the muscular floor of the triangle, either to pierce it on each side near the lateral angles of the interspace, or to run for a short distance between the serous and muscular tunics before entering the latter. As each of these vessels has a fairly well-defined territory, it appears undesirable to interfere with the loops from which they spring, and it is hence safer to divide the mesentery as close as possible to the portion of bowel to be resected, the cut edges of the redundant part left after suture of the intestine being folded and the edges united by fine catgut sutures.

"It is important to remember that the thickness of the *muscular coat* of the small intestine varies within rather wide limits in different subjects, and in all cases diminishes, together with the calibre of the tube, from the upper towards the lower extremity of the canal. In the jejunum, about two feet from the commencement, the depth of the tissue ranges from one-seventieth to one-fortieth of an inch, while in the lower part of the ileum, about two feet from the ileo-cæcal valve, the thickness is reduced to about one-half or even one-third of this measurement. The difficulty and danger of enterorraphy will hence be greater

the more remote the portion of intestine is from the stomach; but fewer sutures will be needed.

"The *submucous tissue* has a considerable degree of toughness, and is usually thick enough to bear a fine suture, applied after Lembert's manner, without implicating the epithelial surface of the mucous membrane."

In connection with the last-mentioned point, it must be borne in mind that the glands of Lieberkühn penetrate the mucous membrane for some distance, and that if the suture pass through them the lumen of the bowel is practically opened. The tough submucous tissue is air-tight and water-tight. It is much better marked in many animals used for experiments (*e.g.* dogs and cats) than in man.

The *cæcum* is almost always entirely covered by peritoneum. In shape and in position it is liable to considerable variations, some of which may be congenital, while others are acquired. The cæcum usually lies upon the psoas muscle, its apex corresponding with a point a little to the inner side of the middle of Poupart's ligament.

The *appendix* is subject to very numerous variations, both as to shape and as to situation. It commonly lies behind the end of the ileum. It is often in close relation with the iliac vessels and the ureter. It is not unfrequently found in the pelvis.

The general disposition of the *colon* need not be here described.

A careful examination of the peritoneal investments of the ascending and descending part of the colon in one hundred bodies gave the following result. In fifty-two bodies there was neither an ascending nor a descending meso-colon. In twenty-two there was a descending meso-colon, but no corresponding fold on the other side. In fourteen subjects there was a meso-colon to both the ascending and the descending segments of the bowel; while in the remaining twelve bodies there was an ascending meso-colon, but no corresponding fold on the left side.

The line of attachment of the left meso-colon is usually along the outer border of the kidney, and is vertical; that of the right

is less vertical, and crosses the lower end of the kidney from right to left, to ascend along the inner margin of that viscus.

The so-called *sigmoid flexure* forms, as pointed out in the Lectures alluded to, a loop which resembles a capital omega, but which cannot be called sigmoid (Fig. 67). This omega loop extends from the point of ending of the descending colon—at the outer border of the psoas—to the middle of the sacrum. It includes, therefore, what is known as the first part of the rectum. Its average length in the adult is seventeen and a half inches. The mobility of the loop is remarkable. Its meso-colon is quite distinctive. Its average length is as follows: Over the psoas, one inch and a half; at the bifurcation of the common iliac vessels, three and a half inches; on the sacrum, one inch and three-quarters (*see* Fig. 67). The outline of the loop, when spread out, is much influenced by changes in the sigmoid meso-colon. Some notable variations in the outline of the omega loop are shown in Fig. 68. These matters are of concern in the operation of inguinal colotomy.

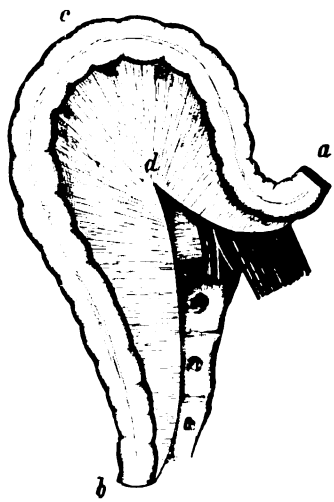

FIG. 67.—THE SIGMOID FLEXURE OR OMEGA LOOP.

a, End of descending colon; *b*, Lower part of rectum; *c*, Summit of the loop; *d*, Neck of the sigmoid meso-colon.

The intersigmoid fossa is in this meso-colon. It is the seat of the intersigmoid hernia, and at its neck is the sigmoid artery.

SUTURE OF THE INTESTINE

The first principles of intestinal surgery involve a consideration of the best method to be adopted for closing wounds and breaches in the bowel, and for bringing together the divided ends of the tube when a segment of the intestine has been resected.

The future of the most elaborate and the most promising

operation upon the intestinal canal may depend upon the integrity of a few sutures. If one stitch fail, the wound in the gut may gape, and fæcal matter may escape.

It may be said literally of some intestinal operations that their success hangs upon a thread.

The history of the suture as applied to the intestine, or the development of the operation of enterorraphy, as some term it, is full of interest.

No more valuable contribution to our knowledge of the subject has been provided than that afforded by Travers's famous

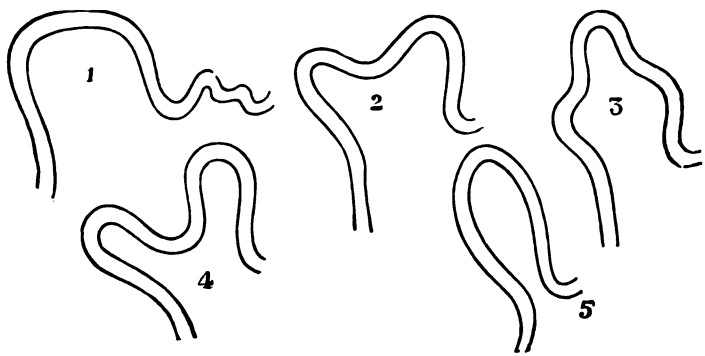

FIG. 68.—DIAGRAM TO SHOW THE OUTLINES OF THE SIGMOID FLEXURE OR OMEGA LOOP AS OCCASIONALLY MET WITH.

monograph, "An Enquiry into the Processes of Nature in Repairing Injuries of the Intestine," published in 1812. An excellent *précis* of the development of this branch of intestinal surgery is to be found in South's edition of "Chelius's Surgery" (vol. i., page 456).

To Ramdohr in 1780 is ascribed the honour of having been the first successfully to unite the bowel by suture after complete division.

Since that time invention has run riot among methods for uniting the intestine, and the forms of suture which have been considered as especially adapted to the bowel are now legion.

The methods devised have been not only very numerous, but also very varied. Some are imperfect, others are bizarre,

not a few are merely curious, many are ingenious, the majority are elaborate.

It is possible, however, to arrange the greater number of the procedures that have been devised under the following divisions or plans :—

Methods.—1. The divided bowel is brought into the abdominal wound and is retained there. No immediate attempt is made to close the breach in the intestine. An artificial anus is of necessity

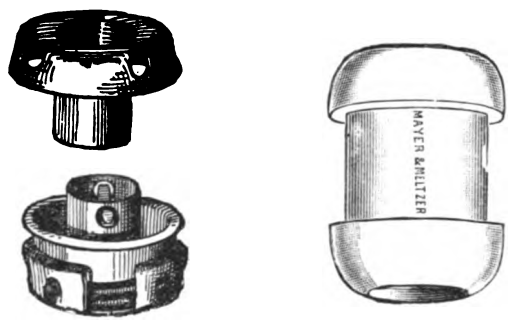

FIG 69.—MURPHY'S BUTTON AND ROBSON'S BOBBIN.

The left-hand figure shows the small size of Murphy's button suitable for use in the small intestine. The right-hand figure shows Robson's decalcified bone bobbin.

established. The closure of this fæcal fistula is left to a subsequent period.

This method is chiefly adapted for cases in which an annular constriction of the gut is present with much dilatation of the proximal part, the intestine below being contracted. Excision of the strictured part with immediate end-to-end union being almost impossible, the method offers a means of draining the intestine with fair safety, and of allowing the upper part to contract. A Paul's glass tube should be inserted in each end. The chief risk comes in the second operation, when the two portions are freed and sutured.

2. The two halves of a Murphy's button are secured by suture in each end of the divided intestine, and are then fitted together. Sometimes a few additional Lembert's sutures are added, but reliance is mainly placed on a plastic inflammation, due to

the pressure of the button, producing union before the button itself works loose in the intestine (Figs. 69 and 83).

3. A rigid cylinder of decalcified bone (the so-called " bobbin ") is introduced, and over this the two ends of the bowel are drawn and so united as to cover in the cylinder. The cylinder or bobbin was said to facilitate the introduction of the stitches, and so shortens the time taken in suturing; it also acts as a temporary splint, and allows the passage of intestinal contents through its lumen. It may be noted, however, that it soon becomes digested or works loose. Thus Sir W. Watson Cheyne, in one case, records that it was vomited up half digested only nine hours after it had been inserted in doing gastro-jejunostomy. Robson's bobbin (Fig. 69) is as good a form as any, but probably few surgeons now employ it. Personally we see little advantage in its use.

4. One end of the bowel is invaginated into the other. If possible, the upper end is introduced into the lower. This method was first practised by Ramdohr in 1780, and has been extensively modified. The earlier operators brought the outer serous coat of the inner or entering segment of the bowel into contact with the mucous lining of the outer or receiving segment. In 1827 Jobert so modified this procedure that the serous coats of both ends of the bowel were brought into contact with one another. To effect this the free (divided) edge of the lower or receiving segment of the intestine was turned inwards.

Invagination is now chiefly employed in the form of Maunsell's operation, and then only as a temporary method to aid accurate suturing (*see* page 261).

5. The divided margins of the bowel to be treated are brought together by careful and accurate suturing, a double row of sutures being applied. This is effected without employing any supporting foreign body, and without producing any invagination of the tube.

6. The two ends of the bowel are closed entirely by a continuous suture in each. The proximal portion is then joined by lateral anastomosis (p. 278), either to the distal one near its closed end, or if this is not convenient, to some portion of gut

lower down. This method involves three distinct acts of suturing. It is complicated, but may not take much longer to perform than end-to-end union. The reason is that the closure of both portions can be carried out quickly by a double line of continuous sutures. Besides the ordinary clamps, crushing ones (such as Doyen's) are often used to break up the mucous membrane at the exact line of suture. Their advantage is, however, doubtful.

The principal and most generally accepted methods of uniting the divided intestine will now be described. These selected methods represent the chief modern procedures concerned in enterorraphy.

Qualifications of a Good Suture.—An efficient intestinal suture should have the following qualifications :—

1. It should bring into contact two broad surfaces of peritoneum, these surfaces belonging respectively to the bowel above and below the breach to be closed.

2. It should effect a complete closure of the wound, the test being that the seam should be water-tight.

3. The suture should be simple, should be easily introduced, and should be capable of effecting a rapid closure of the wound.

4. The thread should take so firm a hold of the tissues that there is no danger of its " cutting out " when strain is put upon it, as may be the case if the viscus become distended.

5. The sutures passing through the mucous membrane should be reinforced by a second row, which includes only the outer coats of the bowel.

6. No unsupported suture should pass through all coats of the bowel—*i.e.* it should not pass from the lumen of the gut to the serous covering of the same.

7. Special care should be taken at the mesenteric attachment to effect close union, as leakage is very apt to occur at this point.

The many complications that have been introduced into the subject are much to be regretted. Simplicity of method with security are to be aimed at. The surgeon who is suddenly called on to resect a piece of intestine or to sew up a wound in it will

not remember the details of a dozen different methods, nor would he be the better for doing so.

In the previous editions of this work the methods which dealt with interrupted sutures were considered separately from those of the continuous one. This is unnecessary, as there is no essential difference, provided that care is taken, when the continuous method is used, not to narrow the lumen of the gut materially. This can easily be effected by breaking the continuity at intervals in the manner to be described. Practically every method that has been invented involves making a fold on the inner surface of the intestine, and where circular enterorraphy is concerned it is obvious that a subsequent stricture *might* result. But this danger has been over-rated, and it is the fact that (1) a longitudinal fold, one made in the axis of the bowel, cannot possibly cause obstruction, (2) a circular fold of mucous membrane of moderate size is no more likely to do so than the normal valvulæ conniventes.

The most important point in intestinal suture is to get a smooth line of firm union of all the coats. This is best obtained by a double row of sutures, the inner a continuous one passing through all the coats, the outer (either continuous or interrupted) for the peritoneum and muscular coat. This is really the Czerny-Lembert suture, modified only by making the inner suture traverse all the coats instead of the mucous membrane only, and by using a continuous instead of an interrupted line.

To illustrate it, we will suppose that a linear incision in the axis of the gut is to be closed.

The **needles** selected for suturing the wound must depend upon the taste and custom of the individual operator. A straight, slender sewing-needle has appeared to us to be the best in most cases, and is especially suited for Lembert's suture. Sutures in the mucous membrane are perhaps more conveniently introduced by means of a curved needle. A curved needle is also used by many for the superficial sutures.

The straight needle should be about one inch and a quarter in length, and must have a round shaft. A common sewing-needle of this length is excellent, and is infinitely to be preferred

to the lancet-pointed or triangular-pointed needles often found in use.

Sutures Employed.—The best suture material is the very finest braided silk. It is strong, is easily manipulated, is of close fibre, runs very easily, and ties in a very small and very firm knot. It does not twist up, and is even more easy to deal with when it is wet than when it is dry. It should, indeed, always be used wet.

Japanese silk is admirably adapted for intestinal work. Linen thread is advocated by some surgeons, and fine catgut is employed by many, but the latter has certain drawbacks. There is no catgut made which has so smooth a surface as fine silk that has been dipped in water. As a consequence catgut "runs" somewhat stiffly. The catgut thread, moreover, is a little rigid, and when tied forms a comparatively large and clumsy knot, which has on more than one occasion given way. In many intestinal operations it is felt that a suture of a more abiding nature than catgut is desirable.

The assistant holds the loop of bowel on either side of the wound, so that his fingers act as a clamp, at the same time putting the wound slightly on the stretch. With a curved needle the surgeon traverses the outer coats just beyond the end of the wound as a starting-point, and ties a double knot. He then passes the needle from one side to the other through all the coats, keeping the successive loops very close together. Arrived at the other end of the wound the thread is drawn gently taut and knotted in the manner shown in Fig. 71. The second row, the most important, consists of Lembert's sutures, either continuous or interrupted. The continuous one, here figured as Dupuytren's (Fig. 70), takes less time, and is equally efficient. Especial care should be taken that the needle does not enter the mucous membrane, lest the thread should become infected, but there is no doubt that in the case of thin-walled gut—such as the lower end of the ileum—this has frequently happened without bad result.

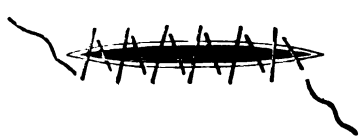

FIG. 70.—DUPUYTREN'S SUTURE.

In circular enterorraphy, end-to-end union of intestine, the same double row of sutures should be employed (p. 258).

We deliberately omit description of various ingenious forms of intestinal suture, some of which (Gély's, Appolito's, and Cushing's) were given in former editions of this work. This is done for two reasons: first, they are very complicated and difficult to remember when wanted, and, second, they rely on a single line of thread, and hence lack the security of the method just described.

One author of authority on abdominal surgery in a recent work warmly recommends it, and condemns all complicated

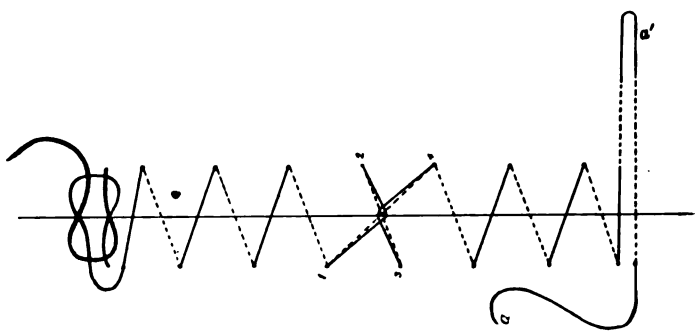

FIG. 71.—A CONTINUOUS SUTURE RUNNING FROM LEFT TO RIGHT.

A double knot is tied at the commencement. After traversing a short distance, the suture is tightened and secured by a loop (1, 2, 3, 4); at its end a second knot is made by tying the single thread (*a*) with the loop (*a'*) in a double knot.

methods. He then devotes several pages to a description with figures of a new variety (Dr. Connell's), both of which are harder to understand than any other.

The principle of Lembert's suture is so important that it may well be further described.

The needle is passed transversely to the line of the wound, and at right angles to the axis of the bowel.

A fold is picked up on one side of the wound; the needle is then carried over to the corresponding spot on the other side of the wound, where a precisely similar fold is picked up. The margins of the wound are turned in, and the serous coats are brought into close contact (Figs. 72 and 74). The

needle should pick up more than the serous coat; it should include a part or the whole of the muscular coat also. It must

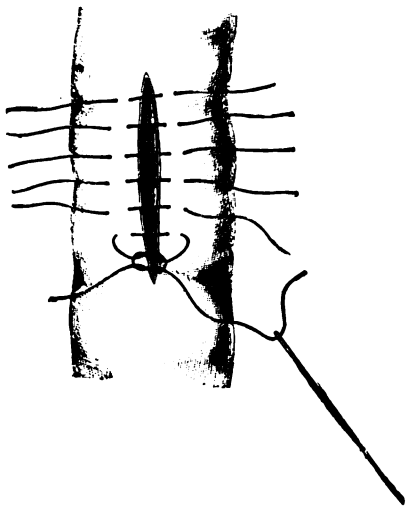

FIG. 72.—LEMBERT'S SUTURE.

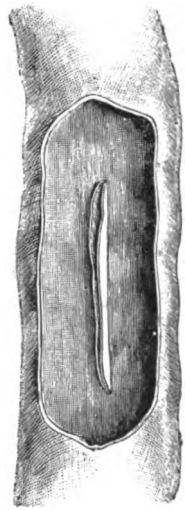

FIG. 73.—LEMBERT'S SUTURE OF THE INTESTINE (as seen from the mucous surface).

on no account trespass beyond the limits of the submucous layer (Fig. 74).

The width of the fold picked up will be from one-tenth to one-twelfth of an inch. The inner row of needle points will be

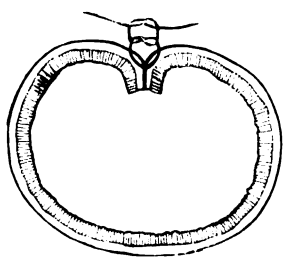

FIG. 74.—LEMBERT'S SUTURE.

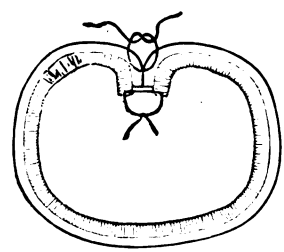

FIG. 75.—CZERNY-LEMBERT SUTURE.

from one-twelfth of an inch to one-eighth of an inch from the edge of the wound. In very small and simple wounds of the intestine the needle may be brought out nearer to the free border

tine have been carried out with a steadily increasing

n *Journal of Med. Sciences*, 1888, pages 1–123) has six examples of excision in gangrenous hernia. ed.-Chir. *Trans.*, vol. lxxii., page 224) has framed cases of excision of the colon for cancer.
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CHAPTER VI

RESECTION OF THE INTESTINE

EXCISION when applied to the lesser bowel is termed enterectomy, and when carried out in the colon, colectomy.

Indications.—Most of these operations have concerned the lesser bowel, and have been performed to remove gangrenous parts in strangulated hernia, or to restore the canal after a fæcal fistula has been produced. Enterectomy has also been performed for the relief of stricture of the bowel, both simple and epitheliomatous, for occlusion due to adhesions and certain neoplasms, for the relief of irreducible intussusceptions, and in certain examples of extensive injury, as after gunshot wounds.

The greater number of the cases of colectomy have been performed to effect the removal of a malignant growth, or to restore the bowel after an artificial anus.

History.—Accounts of the excision of portions of gangrenous bowel in hernia are to be found among the earlier annals of surgery. The operations were a little uncouthly performed, but were attended with some success.

In 1727 Ramdohr successfully removed two feet of gangrenous bowel from a hernia. (*See* paper by Dr. Ill, *New York Med. Rec.*, Sept. 22nd, 1883.)

In 1732 Arnaud excised from a rupture the cæcum, with some part of the colon and ileum. The patient, a man aged sixty, recovered (" Dissertation on Hernias," pt. 2, obs. xvii.).

Reybard in 1843 removed a carcinomatous growth of the sigmoid flexure, together with three inches of the gut. The patient survived the operation, and died of recurrence in twelve months (*Bull. Acad. de Méd.*, t. ix., page 1033).

Within the last thirty years resections of portions of both the large

and the small intestine have been carried out with a steadily increasing frequency.

McArdle (*Dublin Journal of Med. Sciences*, 1888, pages 1–123) has collected seventy-six examples of excision in gangrenous hernia. Kendal Franks (*Med.-Chir. Trans.*, vol. lxxii., page 224) has framed a table of fifty-one cases of excision of the colon for cancer.

Billroth reported (*Brit. Med. Journ.*, Aug. 16th, 1890, page 407) that he had himself performed 140 resection operations upon the stomach and the intestines.

Reichel as long ago as 1883 brought together 121 cases of gut resection for various conditions (*Deutsche Zeits. für Chir.*, 1883, page 230).

Mr. Croft's very admirable paper on rupture of the small intestine (*Clin. Soc. Trans.*, vol. xxiii.) includes a collection of fourteen cases of abdominal section for rupture of the small intestine without wound. In five instances excision was performed.

Of individual cases, one of the most remarkable is that of Koeberlé's. This surgeon removed over six feet of the small intestine from an adult suffering from multiple simple stricture. The operation was successful (*Bull. et Mém. de la Soc. de Chir. de Paris*, 1881, page 99).

The details of the operation will be considered under the following headings :—

1. Enterectomy with circular suturing of the divided ends.
2. Enterectomy with the aid of Murphy's button.
3. Enterectomy with the establishment of an artificial anus.
4. Methods of uniting segments of intestine of unequal size.
5. Colectomy.

I. ENTERECTOMY WITH CIRCULAR SUTURING OF THE DIVIDED ENDS

(1) The abdomen having been opened, the first step is to isolate the loop of intestine to be excised. This loop should be drawn well out of the parietal wound. Any adhesions which

prevent it from being well exposed and isolated must be divided.

If any extravasation has taken place into the abdominal cavity, it should be dealt with before the resection is commenced.

The operator must, moreover, be prepared for the absolute necessity of abandoning the excision altogether.

The disease or gangrene may be found to be too extensive, or the bowel may be so bound down that it would be impossible to isolate it sufficiently to enable a resection to be performed, or the amount of extravasated matter found in the peritoneal cavity may be such that the thorough cleansing of the serous space and the rapid establishment of an artificial anus will be obviously the right course to adopt.

Not only must the loop to be dealt with be well exposed, but healthy bowel both above and below the seat of disease must be brought into view.

The mesentery of the part to be resected should be also examined.

In cases of malignant disease it is needless to say that no resection operation should be entertained in cases in which the disease is other than very clearly limited, or in instances in which the mesenteric glands are found to be involved.

The part to be resected is placed upon a gauze pad or a flat sponge, and the whole wound through which the intestine has been drawn is well and carefully packed all round with gauze or sponges. It should be impossible for any intestinal matter to find its way into the peritoneal cavity.

If the parietal wound has been very large, it may be desirable that it should be closed in part by sutures before the resection is commenced.

(2) The bowel must be occluded above and below the resection area. If sponges have been well packed all around the coil, this precaution may sometimes, and in some special cases, be dispensed with.

Many clamps have been devised for the present purpose. No instrument, perhaps, is so efficient as the fingers of an in-

telligent assistant. The holding of the gut by an assistant, however, is apt to involve two difficulties. In the first place, his hands may come very much in the surgeon's way; and in the second place, it is scarcely possible to retain a proper and equable hold of the gut during the long space of time involved by the operation.

FIG. 76.—MAKINS'S INTESTINAL CLAMP.

Of the various clamps devised, that introduced by Mr. Makins is useful (*St. Thomas's Hosp. Reports*, 1884, page 81) (Fig. 76). The blades are covered with indiarubber tubing, and are long enough to compress the whole width of the bowel. They are simple, and are easily applied and removed. Another useful clamp is that known by Doyen's or Hartmann's name (Fig. 78),

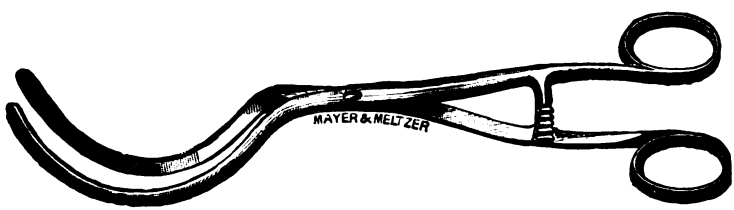


FIG. 77.—SIR THOMAS SMITH'S INTESTINAL CLAMP FORCEPS.
It is unnecessary to cover the metal blades with rubber.

though, as we have said in an earlier chapter, it is practically identical with that introduced previously by Sir T. Smith (Fig. 77).

Some surgeons ligature the bowel lightly above and below, making use of a cord made of gauze, which is passed through a hole in the mesentery. Dr. Senn, in experiments upon animals, was most satisfied with ligatures made of indiarubber bands. The bands are about one-eighth of an inch wide, and are applied by perforating the mesentery at a point free from large visible vessels, and are then tied in a loop with sufficient firmness to obstruct the lumen of the bowel.

A simple clamp or the fingers of an assistant are, however, to be preferred to any form of ligature. The ligature not only exercises an undue amount of compression and involves an injury to the mesentery, but it throws the cut margin of the bowel out of line, and in the case of a dilated bowel is apt to throw it into folds.

The late Dr. Maunsell advised the following simple method :—A flat piece of sponge is placed over the bowel, and the two ends of

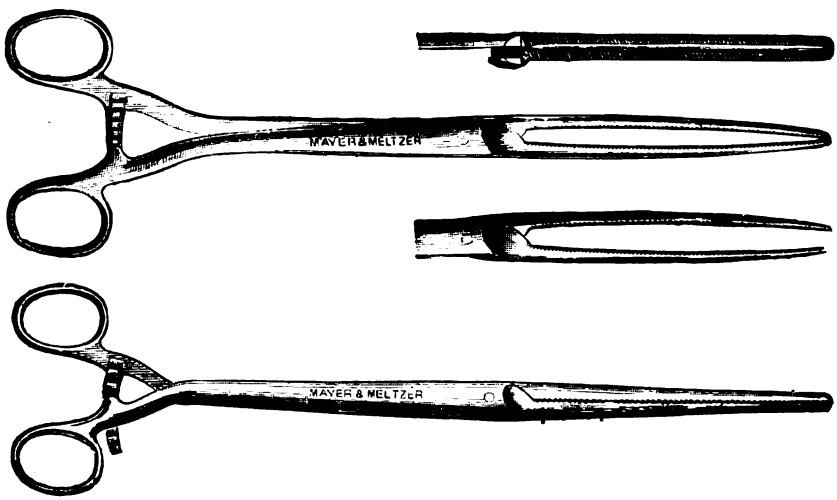


FIG. 78.—CLAMPS FOR GASTRO-INTESTINAL OPERATIONS (Doyen's or Hartmann's pattern). The clamps are made in two halves, which take asunder for aseptic purposes. The degree of pressure on the intestine can be exactly regulated by the catch close to the handle. The lower figure shows the clamp completely closed.

the sponge together with the intervening mesentery are transfixed with the shaft of a large safety-pin. The body of the pin lies over the sponge. By closing the pin the bowel is clamped.

In adjusting clamps (should these instruments be used) the upper clamp will be applied first. The segment of bowel to be excised will then be gently emptied by passing the fingers along it, and the lower clamp will be fixed in position. Little matter should therefore escape from the isolated segment during the division of the coats of the bowel. Before applying the sutures, care must be taken that the bowel above the resection area is not greatly distended. If it be so, the distension must be relieved,

as much gas and fæcal matter being allowed to escape as will find an exit. This is best effected by making an opening in the centre of the loop to be excised, and allowing the intestinal contents to escape into a gutter of thin indiarubber tissue which has been already prepared and put in position. This answers better than the method of loosening the upper clamp after the bowel has been excised.

(3) The portion of diseased bowel is now excised. This is effected with blunt-pointed scissors. The cut must be made about three-fourths of an inch beyond the margin of the clamp. If it be much nearer, it will be found that the clamp interferes with the movement of the needles during the passage of Lembert's suture.

The bowel should be cut straight across, *i.e.* at right angles to its long axis. After such a section, it will be noticed that the divided coats retract a little more on the free than on the attached border of the bowel, and as a result the incision lines tend to diverge a little and to become oblique. It has been advised by some that the bowel be divided by two oblique and diverging incisions, in such a way that more of the intestine is cut away upon the free than upon the mesenteric side. Experiment will show that there is little to recommend this method, and that it involves a less complete restoration of the natural curve of the intestinal coil.

The scissors cut their way from the free border towards the mesentery; on approaching the mesentery care must be taken to save as much of that membrane as possible.

The segment of bowel to be removed may be almost—as it were—enucleated. The mesentery may then be divided as close to the wall of the bowel as is possible.

An account has already been given of the interspace which extends along the whole length of the mesenteric attachment (p. 239). The scissors will open this interspace, and will follow it, dividing the mesentery close to the bowel.

Another—and in most instances a better—method of treating the mesentery consists in excising a triangular portion of the

membrane together with the gut to be removed. The base of the triangle will be at the intestine, but will be narrower than the length of bowel removed. By allowing the mesentery to overlap the divided ends, as it were, the vascular supply of those segments is the less interfered with. The margins of the wound in the mesentery are then carefully brought together by a continuous suture. This measure brings about the neatest adjustment of the parts, and is most efficient in preventing that kinking of the suture line which is so apt to occur after resection operations. In cases of malignant disease it is an advantage to remove the mesentery which contains the lymphatics issuing from the growth. It is insisted upon by some that it involves, however, a greater amount of interference with the vascular supply of the divided ends of the bowel than does the method of cutting the mesentery close to the intestine; but it cannot be said that this point has yet been proved.

(4) The divided ends of the bowel are now thoroughly well cleansed, and all soiled sponges are removed and replaced by fresh ones.

The mucous membrane may be found to protrude considerably, and to appear to interfere with the proper adjustment of the sutures. On no account, however, should any portion of this membrane be pared away.

The two ends of the bowel being placed close together, a curved needle armed with a long silk thread is passed through all the coats exactly at the mesenteric edge. Half the thread is drawn through and tied in a double knot towards the lumen of the gut. This leaves a long end which is temporarily held in a pair of Wells' forceps. With the other end, to which the needle is attached, the surgeon carries his continuous suture through all the coats from the mucous membrane outwards, towards the free border of the gut, *i.e.* that opposite to the mesentery. The suture passes from mucous membrane to peritoneum on one side, then from peritoneum to mucous membrane on the other. A single knot tied in the thread now and then will prevent constriction of the lumen. The sutures should

be placed as closely together as possible. As the free border is reached the suture is left rather loose, another needle is then threaded on the other end which, again starting from the mesenteric edge, completes the union of half the circumference of the gut. The two ends are now drawn sufficiently tight and tied together. The knot must, of course, be made on the outer or peritoneal aspect, but this is of no moment. The ends of the thread are cut short close to the knot, and with a fresh needle and thread the second row of sutures (Lembert's) is commenced. This should again be started at the mesenteric edge. Whether interrupted sutures or a continuous one are employed may be left to the surgeon's discretion, but the continuous one is undoubtedly the quicker method.

The chief difficulty will be found in the first row in bringing the whole circumference of either end of the gut into even and accurate apposition. It is a good plan, after starting the continuous thread at the mesenteric border, to insert one or two guide sutures (through all the coats) with an entirely different needle and thread, at one-third of the distance round the intestine.

It may be once more pointed out that the weak part of the suture line will be at the mesenteric border. It is at the line of the attachment of this membrane that the first stitches are applied. Use must be made of any peritoneum which has been saved from the mesentery, and sufficient must be found to serve as a covering for the bare portion of the bowel. Not only must the muscular coats be well brought together at this part, but inturned flaps of peritoneum covering that coat must also be brought into direct and close contact.

If clamps have been applied they should now be removed.

The surgeon next turns to the mesentery. If a triangular portion has been removed, the margins of the gap are brought together by several points of suture—or, better still, by a continuous suture.

If the mesentery has been divided close to the bowel there will be a large redundant fold to be dealt with. The cut edges

of this fold may be united by a continuous suture. This, however, must not be allowed to suffice. To avoid kinking, to prevent a pouch from being formed, and to give to the suture line the fullest degree of support, the base of this fold of mesentery must be transfixed by a series of sutures, and the two layers of serous membrane in this situation be brought into close contact.

It will be obvious that in the great majority of instances, and notably in cases of malignant disease, this large redundant fold should be removed; or, in other words, that a triangular piece should be cut out of the mesentery together with the bowel.

(5) The bowel is well cleansed, the sponges that have held the coil in place are removed, and the sutured loop is allowed to drop back into the abdomen. The abdominal wound is then closed.

Should a drainage tube be inserted? If the gut has been in a healthy condition, not dilated, and the surgeon is quite satisfied with his suturing, there would seem to be no reason for drainage. But after resection of intestine by the best of operators occasional leakage at the end of a few days has now and then occurred. If then a fæcal fistula can form, the patient's life may be in less danger, and spontaneous closure of the fistula will ultimately occur. But if the surgeon has firmly closed the abdominal wound, the smallest leak will cause fatal peritonitis. The resected loop of gut will generally remain close to the wound, and the presence of a small drain—a spiral rubber tube, for example—can do no possible harm for a week or so. Of course the end of the tube should project only just enough into the abdomen. Some prefer a strip of gauze.

2. ENTERECTOMY WITH THE AID OF MURPHY'S BUTTON

We have already expressed our firm opinion that in all intestinal work the double row of sutures, without any artificial aid, is safest and best. Perhaps it would be best to emphasize this by omitting all reference to Murphy's button, Maunsell's invagination method, etc. But the use of either has in our

hands, as with hundreds of other surgeons, given good results, and neither can be termed quite obsolete. Of the two Maunsell's method is certainly the most rational, though it is more complicated, and takes much more time to carry out than the insertion of Murphy's button. Unfortunately, rapidity of application and mechanical ingenuity are the only recommendations of the button. We shall briefly describe Maunsell's method before passing on to deal with Murphy's button.

Maunsell's Method.—The principle of this method is to secure close apposition of the ends of the gut by a row of sutures which pass through all the coats of the intestine from within outwards, and with the knots placed on the inside of the gut. The following account is derived from the *International Journal of the Medical Sciences*, 1892, page 245:—

The portion of intestine having been excised, the two ends of the bowel are brought together by two temporary sutures which pass through all the coats of both ends of the gut. One suture is placed at the mesenteric attachment of the bowel *b* (Fig. 79, A), and the other at the free margin *a*. The ends of these sutures—which are loosely knotted—are left long. An opening is now made at *c* (Fig. 79, B) in that segment of gut which is the larger of the two—*i.e.* in the proximal part. The incision is on the free border of the bowel, and in its long axis. It will be placed about an inch from the free end of the gut, and its size will depend upon that of the gut to be invaginated. The ends of the ligatures *a* and *b* are introduced into the lumen of the incised bowel, and are brought out through the incision *c*. They are then dragged up so as to invaginate the bowel, and ultimately to bring out the two divided ends of the intestine *d* through the incision *c* (Fig. 79, C). The surgeon now passes a fine straight needle *e* through both sides of the double tube of bowel *d*. The suture is hooked up where it crosses the lumen of this tube, is divided, and tied on either side. In this way twenty sutures can be introduced with ten passages of the needle. The sutures are of fine silk, and serve to unite the divided intestine. Finally, the ligatures *a* and *b* are removed, and the sutured gut *d* is withdrawn (in the direction *f*), the invagination being thus reduced. The longitudinal incision *c* is then closed by Czerny-Lembert sutures, and the slit in the mesentery at *g* is also

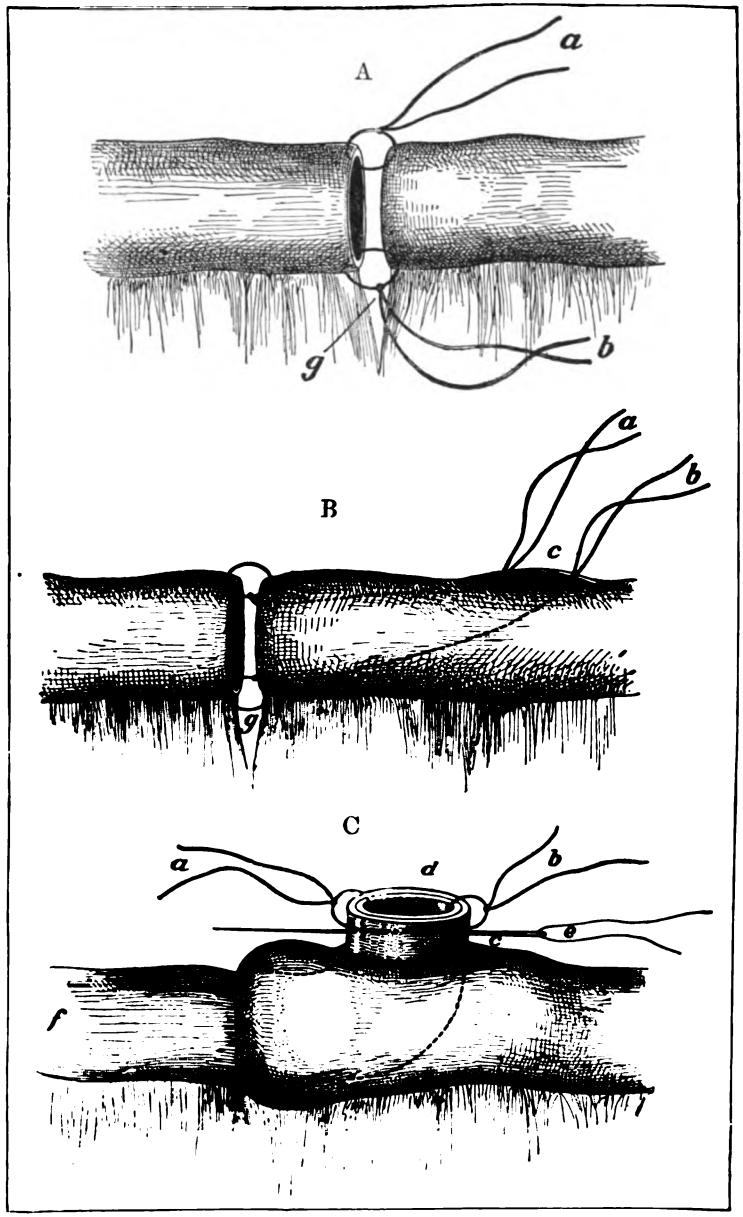


FIG. 79.—MAUNSELL'S METHOD OF UNITING INTESTINE BY THE PROCESS OF INVAGINATION. (For references, *see* text.)

closed by sutures. The united bowel will now appear to be quite straight, and no sutures will be visible.

The *rubber bag* (which has long been abandoned) and *Laplace's forceps* require no description, as they are both quite unnecessary and awkward to employ.

Senn's plates have entirely gone out of use.

Murphy's Button.—With the aid of this ingenious instrument, which was introduced by J. B. Murphy of Chicago in 1895, the surgeon can undoubtedly effect end-to-end union or lateral anastomosis in a shorter time than by any other method. It must be clearly understood

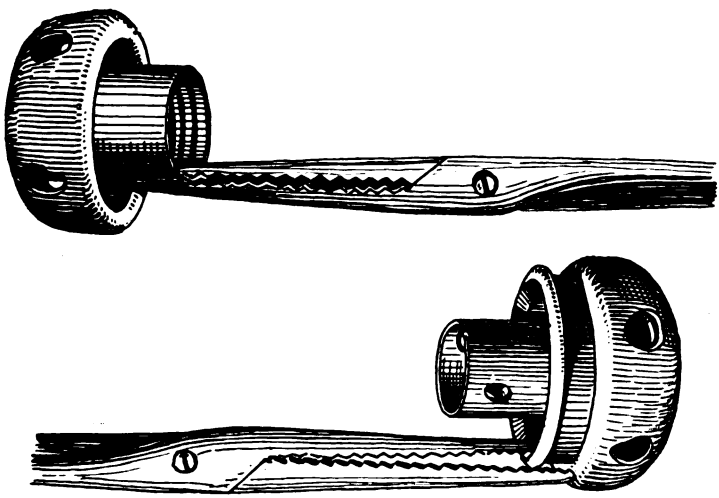


FIG. 80.—MURPHY'S BUTTON. (The lower is the heavier or male half of the button. The spring is seen in the interior.)

that the button produces a plastic inflammation, and, indeed, a variable amount of pressure necrosis. This necrosis ultimately sets the button free, and after some days it passes on into the bowel below. When the button becomes free the plastic union may happen to be just sufficient, or it may be incomplete and leakage may result.

The method of employing the button (attempted modifications of which have at present effected no improvement) will be gathered from the accompanying figures (80, 81, 82, 83) more readily than from a long description.

The two ends of the intestine are clamped or held between the fingers of an assistant some distance from their cut edges. A running

silk suture is rapidly carried round each edge, traversing all the coats; it should begin at the mesenteric attachment, and its free ends are not tied.

In performing lateral anastomosis or gastro-jejunostomy, the running suture is introduced before the intestine is opened. This suture is arranged as shown in the figure, and passes only through the serous and muscular coats of the bowel.

The two halves of the button are then inserted by means of forceps;

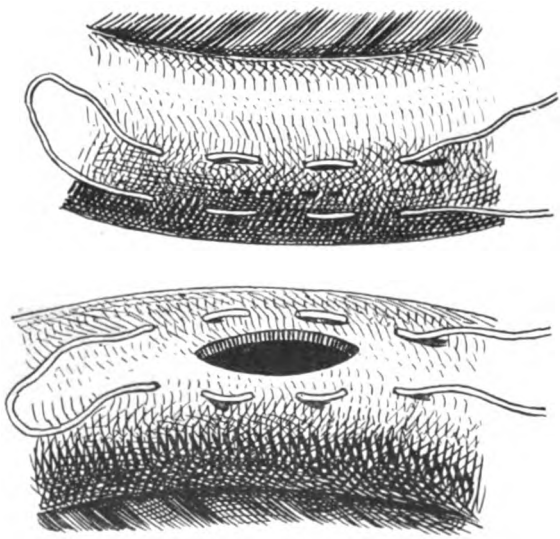


FIG 81.--INTESTINE READY FOR THE INTRODUCTION OF MURPHY'S BUTTON.

(In the upper figure the suture is inserted. In the lower figure the incision for the insertion of the button has been made.)

their lumen may be lightly plugged with cotton wool, which is, of course, removed just before they are fitted together. The heavy "male" half is inserted into the lower segment of bowel, or in gastro-jejunostomy into the jejunum. The stitch is tied securely round the narrowest part of each half, and is cut short. Any redundant mucous membrane is cut off with scissors. The two halves are then fitted to each other, care being taken that they are pressed home with just sufficient force to secure close approximation. It is in this manœuvre that accidents are apt to occur; the halves of the button may jam, the ends of the bowel may be twisted in bringing

them together, or the buttons may be forced together too tightly. The mistake has occasionally been made of trying to fit buttons of

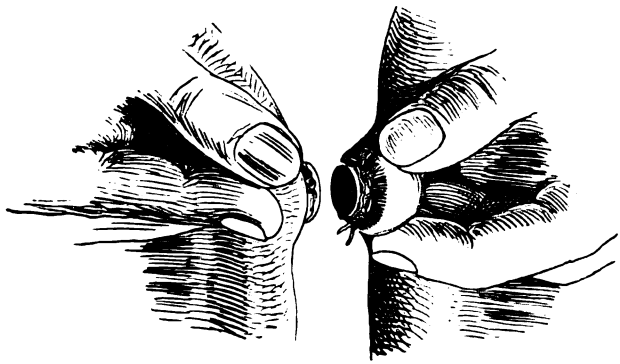


FIG. 82.—MURPHY'S BUTTON IN LATERAL ANASTOMOSIS.
Showing the method of holding the button when bringing the two halves together.

two different sizes together. Finally, a few Lembert's sutures may be applied, but they are not essential.

The time taken in placing the sutures and button need not exceed

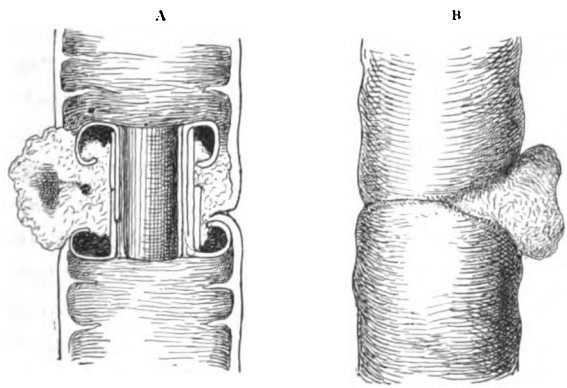


FIG. 83.—MURPHY'S BUTTON USED IN END-TO-END UNION. (From a specimen placed in the Royal College of Surgeons Museum by Mr. P. Furnivall.)
A, Sectional view of intestine, shows the button *in situ*; B, External view of intestine—the lateral projection is composed in part of fat at the mesenteric border.

ten to fifteen minutes, whereas any other satisfactory method will take from thirty minutes to an hour.

It was thought at one time that the use of Murphy's button, with its very conspicuous advantage of rapidity in

operating, would supplant simple suturing. Most surgeons have, however, after trial of the button, returned to the use of direct suture. Resection of gangrenous gut in hernia operations affords a fair test of the relative merits of the two methods. In a paper in the *Clin. Soc. Transactions* for 1900, p. 71, one of us (J. H.) has shown that the percentage of recoveries is considerably higher after suturing than after the use of Murphy's button. Out of fourteen such cases treated with Murphy's button, only one recovered (*i.e.* 7 per cent.); whilst of fifteen treated by suturing, seven recovered (*i.e.* 46 per cent.). Mr. Kendal Franks (*Med.-Chir. Trans.*, 1893) collected a series of cases treated by suturing alone after resection, with a similar percentage of recoveries (rather under 50 per cent.).

In the allied operation of gastro-jejunostomy statistics show a similar advantage of direct suture over the use of Murphy's button, though not in the same proportion as in resection of intestine.

Moreover, in practised hands the somewhat longer time taken by suturing does not appear to have the injurious effect attributed to it. There is a disadvantage in leaving a heavy metal body in the intestine or stomach, and accidents have frequently happened from this cause alone. The retained button has caused ulceration, and has had to be removed by operation.

For example, Mr. F. C. Wallis (*Clin. Trans.*, 1904, p. 42), after performing resection of a large intussusception by means of Murphy's button, was obliged to do a second operation three weeks later in order to remove the button, which had lodged just above the ileo-cæcal valve. The patient recovered.

Another grave objection to the button is that the opening left, if all goes well, is very prone to contract. This has been noticed after both resection of intestine and gastro-jejunostomy, and is illustrated by some specimens placed in the Royal College of Surgeons' Museum by one of us (F. T.).

It should be noted that many cases of resection of intestine have proved fatal owing to excess of caution in the actual excision. It is essential to success that the union be made

in healthy intestine, and not in that already damaged by inflammation. One or two feet of small intestine may safely be removed if necessary, and cases have recovered after excision of as much as nine feet. It must, however, be very rare for more than twelve or eighteen inches to require excision. With regard to gangrenous gut in a strangulated hernia, the rule should be to excise some inches on either side of the strangulated loop. For this and other reasons it is best to perform the operation through a median abdominal wound, and not through that made to expose the hernia.

3. ENTERECTOMY WITH THE ESTABLISHMENT OF AN ARTIFICIAL ANUS

The early steps of the operation are precisely the same as in the procedure just described.

The removal of a triangular piece of the mesentery facilitates the subsequent operation for the closure of the artificial anus. The gap left in the mesentery should be united by suture, as already described.

The use of Paul's glass tubes for the artificial anus not only makes the operation rapid and easy, but it protects the edge of the wound from contamination during the first week, and hence removes the risk of peritonitis. Their use is therefore strongly recommended.

A. The two tubes are chosen according to the size of the intestine—each is continued into a thin rubber tube which conveys all material away into a covered receptacle. Whilst the clamps are still on, each tube is secured in the intestinal lumen by a purse-string suture of silk. Special care should be taken in passing this suture not to go too deeply. When the suture is made tight and knotted the clamps are removed. A few fine silk sutures (Lembert's) should be made to secure the two ends of intestine to the edges of the parietal wound, which is then brought together around them by silkworm-gut sutures. It is important to leave no chink at the side of the intestine through which omentum, etc., may subsequently protrude. This accident

is specially prone to occur, since the condition for which the operation is done always involves distension of intestine and increased intra-abdominal pressure.

A dressing of moist gauze powdered with boric acid is applied around the two tubes, which lie close together in the wound.

The intestinal contents drain away, leaving the wound clean and aseptic for five to ten days: by this time the tubes have worked loose, and of course the wound will become contaminated, requiring constant attention by the nurse. If the patient's condition justifies such a step, it is most desirable to perform the second operation for union of the intestine without delay, before the skin becomes very sore and cachexia from malnutrition comes on.

The above is certainly the best method. The following alternative may be used if the surgeon happens not to be provided with the glass tubes.

B. After the excision has been carried out, the wound in the parietes is so far closed as to leave only a gap through which the divided ends of the gut project. The two sections of bowel—still clamped—should be brought together by their mesenteric borders, and are united by a few points of suture. If time and the condition of the patient allow, the union of the two ends may be carried a little to either side of the mesenteric border. The mucous membrane over the uniting isthmus should be brought together by a simple continuous suture. This partial union of the gut greatly facilitates the operation for the subsequent closure of the fæcal fistula.

The lower end of the divided bowel is now rapidly united to the parietes. The margin of the bowel is secured all round to the margin of the parietal wound. The serous covering of the intestine must be brought into contact with the serous lining of the abdominal wall. The sutures of fine silkworm gut are passed by means of a curved needle. The needle must first transfix the skin, then the tissues of the parietes, then the parietal peritoneum, then the whole thickness of the wall of the intestine.

If the needle be passed in the opposite direction—*i.e.* from mucous membrane to skin—the suture may carry intestinal matters with it into the depths of the wound. Each needle is probably soiled in the using, and therefore no needle and thread should be used for more than one suture. It will suffice if these sutures are about half an inch apart. The mucous membrane is finally attached to the skin in the gaps between the main sutures.

The main sutures may be passed before the clamp is removed, and may be drawn tight and secured when the clamp is withdrawn.

The upper end of the bowel is dealt with in the same way. Every preparation must be made for a rush of fæcal matter as soon as the upper clamp is removed. The skin all round the wound should be thickly smeared with boric ointment or some similar dressing. The patient should be kept turned on the side so as to make the opening dependent. The wound will want constant attention, and the pads used should be of the softest possible nature, Gamgee tissue answering well for the purpose.

This method of operating is commented upon in a subsequent section (p. 273).

4. METHODS OF UNITING SEGMENTS OF INTESTINE OF UNEQUAL SIZE

The bowel above the segment resected may be much dilated, while the tube below is much contracted. In such a case the two parts to be united may be brought to more nearly the same size if the distension of the upper part of the bowel be relieved by allowing its contents to escape.

This, however, should on no account be effected by removing the clamp and allowing a stream of foul stuff to pour over the edge that is to be sutured. A trocar and cannula should be introduced *above* the clamp (preferably some inches away from it), and the intestine emptied through the cannula with every care to avoid leakage by pressure through a fold of gauze. The cannula opening is subsequently closed by sutures.

If, however, the bowel above the part to be removed be greatly

dilated, and the bowel below be greatly contracted, then there must have been a severe grade of intestinal obstruction, and in such a condition the enterectomy should be concluded by establishing an artificial anus.

When, however, the cæcum has been excised, and the ileum has to be united to the colon, the following measure may be adopted :—

Billroth's Method, or Lateral Implantation.—Assuming that the cæcum has been excised, the end of the colon is closed by sutures. This is effected by invaginating the free margins of the divided gut, so that the serous coats are brought into close contact. The parts are united by sutures, preferably by a double row.

A slit is now made in the wall of the closed colon. This slit is vertical—*i.e.* in the long axis of the colon—is placed upon that margin of the gut which is opposite to the attachment of the meso-colon, and is situate about two inches from the closed end. The size of the slit will correspond to the size of the divided end of the ileum.

The end of the ileum is implanted in the slit, and is secured there by very careful suturing.

An alternative method, which may be applied to any part of intestine, consists in lateral anastomosis (*see* page 278). Both ends of the bowel are entirely closed by a double row of sutures. A lateral communication is then made a few inches higher up. The method is not a very satisfactory one.

5. COLECTOMY

The operation for resecting portions of the colon differs in no essential particular from that applied to the small intestine.

After the diseased segment has been removed, the two divided ends of the intestine may be brought together and united by sutures, or any attempt at immediate union may be abandoned, and an artificial anus be established. In colectomy the latter procedure is more frequently carried out than is the case when the small intestine is dealt with.

If the upper end of the bowel, that above the obstruction, is much dilated whilst the lower end is contracted, end-to-end suture should not be attempted until the distension has been relieved.

An artificial anus may be established as a temporary measure, and may be followed by an attempt to close the opening at a later period by a second operation. In such a case the two ends of the divided colon are brought close together, and may even be united partially by a few sutures applied upon the deep or attached aspect of the gut.

Two of Paul's angular glass tubes (Fig. 87, page 291) should be inserted, one into each end of the gut.

If, on the other hand, it be intended that the artificial anus should be permanent, then it is well to close the opening in the distal segment of the bowel. This especially applies to resections carried out low down in the colon.

In closing the distal end it is well to turn in the edges a little, and to bring the serous coats of the bowel together so far as is possible.

The great majority of cases in which colectomy has been performed have been cases of malignant stricture of the bowel.

The amount of intestine removed has varied from two to twelve or more inches. In many instances the whole cæcum has been excised, together with portions of the ascending colon and ileum.

In one case I (F. T.) excised the whole of the descending colon, sigmoid flexure, rectum, and anus. The patient made a good recovery. (*See* "Intestinal Obstruction," 1899, page 256.)

The best position for the incision in the parietes offers some difficulties. The most practical rule is that which would direct the incision to be made immediately over the tumour when a tumour exists.

In any case of doubt a small exploratory incision should be made in the median line, and this may be followed if necessary by a second incision directly over the seat of the disease.

Very little can be done through the median line. The transverse colon can be dealt with through an incision so placed;

but with regard to other segments of the colon much depends upon the mobility of the diseased part and upon anatomical conditions. The summit of the sigmoid or omega loop may be excised possibly through a median incision. It is conceivable also that under certain conditions the cæcum may be resected through a like incision. The circumstances, however, must be exceptional; while for the treatment of the ascending and descending portions of the colon the median wound is of no avail.

In every instance it is desirable that the diseased bowel should be reached by the shortest and most direct route.

Portions of the ascending and descending colon have been excised through the loin, through an incision identical with that used in lumbar colotomy. Sufficient room, however, is scarcely to be obtained through such a wound, the surgeon's movements are hampered by the restricted space in which he must manipulate, and the freeing of the bowel above and below the seat of the disease cannot be so efficiently carried out.

Should the cancerous stricture be situated at the hepatic or splenic flexure (especially the latter), colectomy is both very difficult and dangerous, owing to the deep position of the gut. It is best for the surgeon in such a case to content himself either with lateral anastomosis or with colotomy. Of these two operations colotomy (in transverse or ascending colon respectively) is much the safer and more easy to perform.

The details of the actual operation call for no especial remark, and the account above given of enterectomy will apply to the resection when performed upon the large intestine. The mesocolon, when it exists as a complete fold, is dealt with in the same manner as the mesentery.

It is almost essential to bring the involved part of the bowel out of the wound in order to prevent septic infection. Doyen's clamps placed some inches away from the cancerous stricture afford the best means of occluding the gut after the loop has been emptied by the fingers. Simple suturing should always be resorted to, except in cases in which the patient's condition necessitates a very speedy operation; in such cases Murphy's button may be used.

In applying the first row of continuous suture through the two mucous coats the operator begins at the mesenteric attachment, the most difficult part to obtain perfect union. Five-sixths of the circumference of the gut can thus be united from the inner surface, the remaining sixth being completed from outside. The second suture, a continuous Lembert one, is applied so as to include all the coats except the mucous membrane. The clamps should be removed as soon as possible. During the manipulations the area of union is guarded by sterilised gauze or soft flat sponges.

Comment upon Resection Operations. — The operative measures above described are serious, and have been attended in the past with a high mortality. With improvement in the technique of the operation, and with an increased knowledge of the best means of managing the bowel, the death-rate has been considerably modified.

The main point which needs consideration is the question as to which is the better method of performing resection—the method which concludes by circular suture of the divided ends of the bowel, or that which leads to the establishment of an artificial anus.

It is obvious that the former of these two methods is the more complete, and is, from a theoretical point of view, the more perfect and satisfactory. The diseased portion of the bowel is removed, the continuity of the canal is restored by suturing, and the abdominal cavity is closed.

It will be evident, however, that this method of performing resection involves a considerable expenditure of time, and that, to be surely successful, it requires all those conditions which contribute to the success of any extensive plastic operation. The general state of the patient should be favourable, and the local condition should be good.

Enterectomy, followed by circular suturing of the bowel, is a plastic operation in which perfect and immediate primary healing is essential; and such healing can scarcely be looked for when the patient is *in extremis* at the time of the operation,

when the bowel is suffering from long-abiding distension, or when the peritoneal cavity is the seat of fæcal extravasation.

Nevertheless, in such a grave condition as gangrene of gut in a strangulated hernia, primary resection offers the best prospect of recovery. The mortality is, of course, high. That of various recently published lists (*i.e.* between 1900 and 1908) ranges from 20 per cent. at the lowest to 75 per cent. at the highest.

Enterectomy, followed by circular suturing of the divided ends of the bowel, may be especially advised under such conditions as the following :—

(1) Cases of injury (*e.g.* gunshot wound and stab) in which the whole of the damaged part can be readily excised, in which the injury is recent, and in which the condition of the patient is good.

(2) Cases of growth involving the intestine, in which no marked degree of intestinal obstruction has been produced, and in which the general and local conditions are favourable.

(3) Grave disease involving the jejunum high up. The high mortality attending fistulæ in the upper part of the jejunum is well known.

In all these cases the state of the patient must be such as to enable him to withstand a long and tedious operation, and the local conditions must be such as would be required for the efficient performance of a plastic operation in other parts of the body.

In instances in which obstruction of the bowel exists a temporary fæcal fistula should be established.

The lives of such patients are threatened by reason of the obstruction, and the artificial opening gives immediate and entire relief.

If the divided ends be united by suture directly after the resection, the distension to a great extent remains, and the obstruction is but imperfectly relieved, since the gut at the suture line remains paralysed.

Such patients are, as a rule, already in a position of great danger when the operation is performed. They are not in a condition which would enable them to undergo a long and elaborate operation. The state of the intestinal wall is not such as would

encourage sound and rapid healing, and the over-distended condition of the tube lends itself to the production of leakage at the suture line.

In *Colectomy*, the objection to the formation of a temporary artificial anus is less obvious. At the same time, the patient may be better able to submit to a procedure which involves so great an expenditure of time as does the suturing of divided bowel. The colic cases demanding operation are seldom so acute as the enteric.

One fact must not be forgotten, which is that an artificial anus involving the large intestine is—other things being equal—less easy to close by a subsequent operation than is a like fistula in the lesser bowel.

After-treatment.—The treatment of the patient after one of these operations is conducted upon the same general lines as are observed after all serious abdominal operations.

As already noted, it may be best not to keep the patient on his back, but to turn him over towards the side on which the artificial anus has been made. Again, if primary union of the intestine has been performed it is by no means necessary to maintain the supine position, as the escape of flatus, etc., is favoured by the patient being turned on the side.

The knees may be bent over a large pillow.

The bandage around the abdomen should not be too tight.

The diet must at first be kept low. It is, however, a great mistake to starve the patient. Strong meat-juice or brandy-and-egg mixture may be tried in small quantities frequently given, provided there is no sickness. The food taken for the first week should be small in bulk, and of such a kind as to leave little *débris* in the alimentary canal. Milk in large amount is not to be advised. Ice should be avoided; it often appears to induce intestinal pain.

Nutrient enemata may be of value, and thirst may be quenched by rectal injections of warm water.

Distension of the bowel is relieved by hypodermic injections of strychnia (gr. $\frac{1}{60}$), by enemata containing an ounce of turpentine or a drachm or two of ox-bile. Drachm doses of sulphate of soda and magnesia may be given by the mouth.

Considerable relief usually attends the occasional introduction of the rectum tube.

The first action of the bowels should be on the fourth or fifth day.

Results of Resection Operations.—Dr. McCosh (*New York Med. Journ.*, March 16th, 1889) has collected 114 cases of resection of gangrenous intestine in strangulated hernia. In every instance the bowel was united at once by sutures. Fifty-seven died, and fifty-seven recovered.

Reichel, in 1883, collected 121 examples of resection of the bowel for various causes. Out of this number fifty-eight died, fifty-eight are described as cured, and five recovered with a fæcal fistula (*Deutsche Zeitsch. f. Chir.*, 1883, page 230).

Resection of the small intestine for conditions giving rise to obstruction showed a mortality of 75 per cent.

Mr. Makins (*St. Thomas's Hosp. Reports*, 1884, page 81) has collected thirty-nine cases of resection for artificial anus. Of these fifteen died, three were left unrelieved, and the remaining twenty-one were cured.

In Dr. Morton's tables of 234 cases of "Abdominal Section for Traumatism" (Chicago, 1890) will be found sixteen examples of resection of the bowel for gunshot wound or stab. Of these twelve died and four recovered.

Mr. Kendal Franks has collected fifty-one examples of colectomy for malignant disease (*Med.-Chir. Trans.*, 1889). The mortality was about 57 per cent., and it is noteworthy that this mortality was not influenced by the method adopted—*i.e.* it was the same when immediate suture was carried out as when an artificial anus was established. In recent years the mortality of these operations has been considerably reduced. For example, Mr. Bilton Pollard (*Brit. Med. Journ.*, Jan. 23rd, 1904) has recorded seven cases of resection of part of the large intestine for carcinoma: all the patients recovered, and in several life was prolonged for two or more years. In one of the cases (cancer of the splenic flexure) it was necessary, owing to adhesions, to remove the left kidney and part of the pancreas.

One of us reported fifteen cases of primary resection with end-to-end suture for gangrenous gut in hernia. Of these patients seven recovered (*.ie.* about 50 per cent.) (J. Hutchinson, *Clin. Soc. Trans.* for 1900)

CHAPTER VII

INTESTINAL ANASTOMOSIS

By intestinal anastomosis is understood the establishment of a permanent fistulous communication between the intestine above and the intestine below the seat of some more or less permanent obstruction. The operation is performed either as a preliminary to subsequent resection of the obstructed portion, or as a palliative measure only.

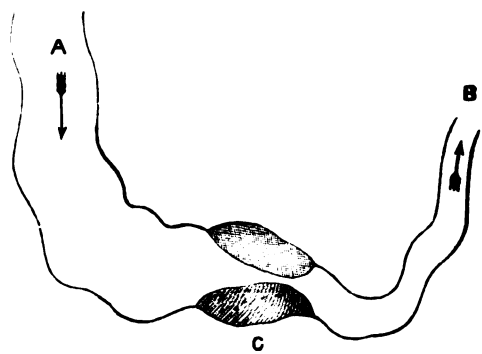


FIG. 84.—INTESTINAL ANASTOMOSIS.—DIAGRAM OF A SECTION OF INTESTINE.

A, Upper end of bowel; B, Lower end of bowel; C, Malignant stricture.

The general procedure may be illustrated by an imaginary case of malignant stricture at the junction of the jejunum and ileum (Fig. 84). Some obstruction has been produced, and therefore the intestine above the growth is dilated (A), whilst beyond it is much contracted (B). It is not considered advisable to excise the diseased segment, owing to the difficulty and risk of uniting two parts of such unequal calibre as well as the probably inflamed condition of the distended part (A). To overcome the occlusion, a loop of the lower part of the jejunum is brought to a loop of the upper ileum, and a permanent opening is established between the two.

The segment of bowel which is the seat of disease is thus excluded from the intestinal canal, and the intestinal stream is diverted into a new channel (Fig. 85).

The idea of establishing such a communication between the bowel on either side of an obstruction originated with Maisonneuve, who performed the operation in two cases. Both patients died, and the proposed measure fell into contempt. The subject was revived in 1863 by Hacken, who carried out some experiments upon dogs. The operation, however, still remained in obscurity until it was revived by Dr. Senn, of Chicago, with whom must rest the credit of bringing intestinal anastomosis into the area of practical surgery.

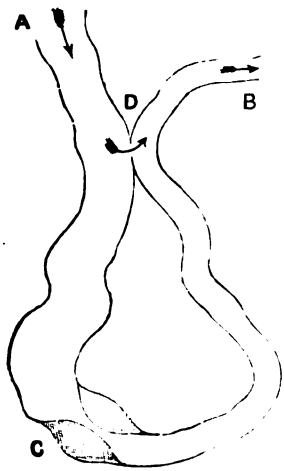


FIG. 85.—INTESTINAL ANASTOMOSIS.

A, Upper end of bowel; B, Lower end of bowel; C, Malignant stricture; D, Site of intestinal anastomosis.

It is impossible to lay down any rule that will apply to all cases for which anastomosis may be indicated, and a short description of the method of performing this operation must here suffice. Although the surgeon may occasionally be led to employ Murphy's button for lateral anastomosis with the idea that time is saved thereby, there is now no question that simple suturing is the safest and best method. We shall therefore describe this alone.

Lateral Anastomosis by Suturing.—The two pieces of intestine which it is intended to join together are drawn out of the abdominal wound and supported by warm sterilised compresses or flat sponges. The contents are expelled by gentle pressure, and clamps applied above and below the site of anastomosis, one pair of clamps holding each loop of intestine. Smith's or Hartmann's clamps will be found convenient (*see* Figs. 77, 78, pages 255, 256). The free surfaces of either piece of intestine are turned towards each other, and it is ascertained that they can be easily made to lie in contact, and that the clamps do not interfere with this. On the convex surface of each intestinal loop a continuous suture of fine silk, which traverses the coats down to the sub-

mucous layer, is passed, being knotted at its commencement. The suture follows the axis of the intestine holding the two loops together for a distance of two inches. Just in front of this the intestine is opened for from one and a half to two inches by a longitudinal incision made with a tenotomy knife or fine scalpel, and enlarged with fine scissors. Any fluid contents which have remained after clamping are wiped away. A continuous suture —fastened off at short intervals by knots—is then carried through the whole thickness of the circumference of the wound on either side. Finally, the continuous suture is resumed and carried through the outer coats of the intestine in front of the anastomotic opening. The clamps are removed as soon as possible, a few Lembert's stitches applied wherever it seems advisable, and the loops returned into the abdomen after gentle cleansing.

The method described differs hardly at all from that given in the section on Gastro-jejunostomy, and the reader may be referred to Figs. 60 (page 207) and 62 (page 209) for illustrations of the method of suturing.

CHAPTER VIII

ENTEROTOMY

THE term enterotomy is applied to an operation which is carried out in cases of intestinal obstruction, and which consists in opening the distended bowel above the seat of the occlusion and allowing its contents to escape. This involves, of course, an abdominal section.

The procedure is sometimes known as "Nélaton's operation." It is assumed that the loop of bowel which is opened will belong to the small intestine, and in the majority of instances this proves to be the case. It has always been considered a feature of the operation that after the abdomen has been opened, the most convenient distended coil which presents should be incised and a fæcal fistula forthwith established. It will be obvious that the term enterostomy would more precisely represent this operation than the term enterotomy, which would imply the mere cutting into the bowel, as in the removal of an impacted gall-stone.

The usage of many years has, however, established the position of the latter term, and the title enterostomy is employed by few.

Enterotomy for intestinal obstruction was first performed by Nélaton in 1840. He laid open the abdomen in the right inguinal region, and drew forth the first distended coil of intestine which presented.

The Operation.—The abdomen is opened in the right iliac region—if Nélaton's method be strictly followed—by an incision parallel to and a little above the outer part of Poupart's ligament.

The incision is placed to the outer side of the epigastric artery, and its length must depend upon the thickness of the parietes.

One inch and a half to three inches will represent the extremes. French surgeons advise a cut of 7 cm. (2¾ inches).

As soon as the abdomen is opened, the first distended coil of intestine that presents is seized and drawn into the wound. It will probably belong to the lower ileum.

The convex part of the distended knuckle is drawn well into the parietal wound, but the convex or free border should alone project.

The gut should not be twisted from its natural position—that is to say, the spontaneous direction it has assumed should be preserved.

The wound in the abdominal parietes is now partly closed by means of silkworm-gut sutures which are introduced at the two extremities of the wound (Fig. 86).

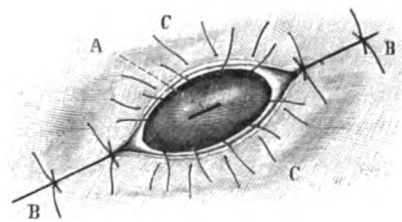


FIG. 86.—ENTEROTOMY.

A, Site of opening in bowel; B, Sutures of parietal wound; C, Sutures between the skin and the intestinal wall.

The bowel will occupy the centre of the wound, and a sufficient number of sutures (two probably on either side) must be introduced to fix the gut in place by the mere narrowing of the parietal incision.

The sutures must include all the tissues forming the parietes, together with the peritoneum.

The latter membrane should be brought as near to the cut margin of the skin as is possible.

The wall of the bowel is now rapidly stitched to the margin of the skin, which tightly surrounds it on all sides. Very fine silk, passed by means of a small curved needle held in a holder, is best adapted for this purpose. The stitches should involve the skin and the serous and muscular coats of the bowel (Fig. 86). Care should be taken not to open the actual lumen of the gut with the needle. In cases of great distension this is not easy. To save time, two operators may be engaged simultaneously upon this stage of the procedure.

A Paul's glass tube of small calibre is now taken up and the diameter mentally marked on the intestine. A purse-string suture is then made to circumscribe the area to be incised, both ends of the suture being left long. With a tenotome or fine scalpel the intestine is opened within the area, one edge of the wound held aside with fine forceps, and the tube introduced. The suture is now tied firmly round the groove in the tube; the latter is packed round with sterilised gauze, the distal end of the tube being provided with a long and thin rubber tube along which the contents as they escape can be conveyed into a receptacle containing a disinfectant. A large dressing of cotton wool held in place by a bandage completes the operation. The glass tube comes away, as a rule, in from five to eight days. As the contents of the small intestines are comparatively fluid, the Paul's tube need not be so large as that employed in colotomy.

Supposing that a Paul's tube is not at hand, the following procedure is employed:—

The gut is opened by a small puncture. This should be effected with a scalpel, and not with a trocar.

The small sutures that connect the gut wall with the skin are for the purpose of shutting off the peritoneal cavity. They would not suffice probably to hold the intestine safely in position.

To effect this latter object two lateral sutures of silkworm gut should be introduced, and should transfix the whole thickness of the intestinal wall except the actual mucous membrane, and take a firm hold of the integuments.

These sutures should be passed from without inwards, *i.e.* from the skin towards the gut. If passed in the opposite direction, they may carry fæcal matter into the tissues.

The opening into the bowel should always be small, and should be upon the free or convex border.

The smaller the knuckle of intestine brought into the wound, and the smaller the fistula, the easier will be any subsequent operation for the closure of the artificial opening.

The operation as above described can be carried out in a

remarkably short space of time, and with the least possible amount of disturbance of important structures.

After the gut has been incised, there should be no squeezing of the abdomen, and no attempts to wash out the lumen of the bowel. The distended tube should be left to empty itself in its own way, and the less the process is interfered with the better.

A light dressing of absorbent wool, which may need to be changed at first every few minutes, is all that is needed.

The skin around the opening should be frequently dried, and then covered with lanoline.

Modifications of the Operation.—The incision may be as conveniently made in the median line below the umbilicus. The fingers are introduced, and an examination of the abdomen is made. It is possible that a band or some equally simple cause of obstruction may be discovered and remedied and the fæcal fistula be rendered unnecessary.

Such examination may enable the surgeon to select for his artificial opening a loop of intestine as near as is desirable to the seat of obstruction. The first loop which presents in the wound may be some distance from the place of occlusion.

Such a modification, although often advisable, is opposed to the chief principle of enterotomy, which is that relief be given to distended bowel in the simplest manner, with the least possible expenditure of time and the least possible disturbance of parts. The opening has on many occasions been made in the left groin instead of in the right. In such a case it is probably the sigmoid flexure which is opened.

If time permit, it is well, before drawing a knuckle of gut into the parietal wound, to unite the peritoneum all round to the margin of the divided skin. When the bowel comes to be fixed in place, peritoneum is brought in contact with peritoneum, and a more speedy and certain sealing of the abdominal cavity is ensured.

Various methods of securing a loop of bowel in the parietal wound will be found described in the section on Inguinal Colotomy, to which the reader is referred (page 288).

If the symptoms be not urgent, the operation may be performed *à deux temps*. The abdomen is opened and the bowel is fixed in place, but its lumen is in no way invaded. The part is dressed with a light pad of moist gauze. After an interval varying from a few hours to three days, the operation is completed by incising the gut and allowing its contents to escape.

In abdominal section for intestinal obstruction, in which the cavity has been widely opened up and determined attempts have been made to remove the cause of the obstruction, an enterotomy may be carried out as a forlorn hope, all other attempts at relief having failed.

Value of the Operation.—Enterotomy is of undoubted value in urgent cases of intestinal obstruction when the patient is in immediate danger of death from the actual obstruction. The operation relieves the bowel rapidly and completely, and many lives have thus been saved. It does not profess to touch the cause of the disease, although there are not a few examples of acute intestinal obstruction which have been permanently relieved by evacuating a distended bowel.

The great object in the treatment of acute intestinal obstruction is to empty the bowel. The patient is being poisoned by the retained contents of his own intestine, and the pressing need is to empty the gut at once of its noxious contents. Of course the most satisfactory plan is to empty the distended gut by enterotomy, and, provided the cause of obstruction has been relieved, to close at once the wound. This can be effected by a straight glass tube or Paul's rectangular one, in either case secured at one end to a long and thin rubber tube. A silk suture is first carried round a small area of the gut at the extreme lower end of the distended portion. Within this area an opening just large enough to admit the tube is made—the latter is passed in towards the upper end of the gut and secured by the knotted suture. By drawing out the coils of gut in warm towels and gently emptying them downwards a pint or two of fluid may be drained off. When the gut is empty the purse-string suture is cut and the tube removed. The small wound in the intestine is readily

closed by a double row of continuous suture, the first through all the coats, the second a Lembert one.

Dr. Curtis' analysis of sixty-two cases of enterotomy for *acute* intestinal obstruction gives the following results :—

Relieved by the operation ...	46 cases	= 72 per cent.
Not relieved	16 ,,	= 28 per cent.
Recovered	32 ,,	= 51·7 per cent.
Passage of fæces *per anum* resumed in	19 ,,	= 60 per cent. of the recoveries.
Died...	30 ,,	= 48·3 per cent.

In the fatal cases it is to be noted that the fistula sometimes failed to relieve the obstruction (in three instances it was below the seat of it), and that gangrene of the gut subsequent to the operation is a frequent cause of death.

The whole matter is more fully dealt with in my (F. T.'s) work on "Intestinal Obstruction."

CHAPTER IX

COLOTOMY

By colotomy is understood the operation of establishing an artificial anus in the colon. This may be either temporary or permanent. But for the fact that the term colotomy has become firmly engrafted in the language of medicine, the more precise term colostomy might be advised.

Colotomy is carried out for the relief of obstruction of various kinds in the colon, and is most frequently employed in case of cancer of the rectum. It is performed also as a palliative measure in some examples of cancer of that part in which no obstruction exists.

Under such conditions it is used to divert the course of the fæces, and with a like object colotomy is performed in the treatment of recto-vesical fistula, and in intractable ulceration of the rectum and lower colon. It is performed also for imperforate anus in infants after the local operations have failed.

Colotomy may be performed in almost any part of the colon from the sigmoid flexure up to the cæcum. It is interesting to note that the earliest form of the operation (see the history which follows) was the iliac or sigmoid opening. This was later superseded by the lumbar operation, on the grounds that the latter was extraperitoneal, that the opening was more conveniently placed, and that prolapse was less likely to follow. After a period of contest between the advocates of lumbar and inguinal colotomy the latter method has triumphed. But although colotomy to most now implies a sigmoid opening, it should not be forgotten that excellent results have followed an opening into the transverse colon, and that now and then lumbar colotomy is advisable.

A cæcal fistula should be avoided if possible, since the fluid

contents of the cæcum are apt to irritate the skin and to make the patient's condition a misery. If a temporary opening into the cæcum is required (*e.g.* for the treatment of ulcerative colitis) the vermiform appendix should as a rule be used instead of making an incision into the cæcum. We will describe in full (1) left inguinal, and briefly refer to (2) lumbar, (3) transverse, and (4) right inguinal colotomy, including cæcostomy by means of the vermiform appendix.

History of the Operation.—Colotomy was first proposed by Littre in 1710 (*Mém. de l'Acad. des Sc.*, Paris, vol. x., page 36). He advised the opening of the sigmoid flexure in the iliac region in certain cases of imperforate anus. The first iliac colotomies performed in England appear to have been carried out in 1821 by Freer and Pring (*Lond. Med. and Phys. Journ.*, 1821, page 9).

Lumbar colotomy was first advocated by Callisen, of Copenhagen, in 1817 (*Systema Chir. Hodiernæ*, t. xi., page 842, Hafniæ, 1817). He proposed to open the descending colon through a vertical incision in the loin. Jean Zalema Amussat carried out lumbar colotomy with success in 1839 (*Mémoires*—three in number—published in Paris, 1839-43). He employed a transverse incision, and extended the operation to the ascending colon. Out of six patients upon whom he operated, five recovered.

Among the earliest operators in England by the lumbar method were Curling, Hilton, and Bryant. Mr. Bryant's first lumbar colotomy was performed in 1859, and he believes that this was the second operation of the kind performed in England—a colotomy by Hilton having been the first (Bryant, "Bradshaw Lecture," 1890, page 3).

To Mr. H. A. Reeves, of the London Hospital, is largely due the introduction of left inguinal colotomy into this country, and his methods have received no important modification. In 1881 he published papers advocating inguinal colotomy in preference to the lumbar operation, a proposal which met with marked hostility. In 1892 (*Brit. Med. Journ.*, Jan. 9th, page 67) Mr. Reeves described the use of the vulcanite rod or rubber tube passed through the mesentery. The credit of these improvements is usually given to others.

The mortality attending colotomy has been in recent years very considerably improved, and the operation once regarded

as a desperate and uncertain procedure and a last resort has come to be employed as a sure means of giving relief, and as a measure which may be carried out comparatively early in the progress of the diseases concerned.

I. INGUINAL COLOTOMY

This operation has been rendered easier and more simple of late years, and the introduction of Paul's tubes has made immediate opening of the bowel a safe proceeding. Inguinal colotomy, as already implied, has almost entirely supplanted the lumbar operation, and is the operation to be chosen whenever the large intestine requires to be opened, provided that the obstruction is below the upper part of the sigmoid flexure.

Instruments Required.—Scalpels and blunt-pointed bistoury; scissors; fine-pointed forceps; several Wells' forceps; blunt hooks; retractors; straight and curved needles; needle-holders; silk sutures, etc. Sometimes a wooden, ivory, or glass rod is employed for fixing the intestinal loop outside the wound. A strip of gauze or piece of drainage tube or rubber catheter will serve the same purpose.

The Operation.—The chief points to be remembered are: (1) to make as short an incision through the muscular wall of the abdomen as possible; (2) to open the highest part of the sigmoid flexure that can be drawn into the wound without undue tension; (3) to ensure an efficient spur being made out of the posterior wall of intestine.

By these means fæces are prevented from passing on into the rectum, prolapse of the intestinal wall is to a great extent avoided, and a certain amount of control over the artificial anus is obtained.

The exact position of the wound is not of great importance. A convenient guide is a line drawn between the umbilicus and the anterior superior spine on the left side; at a distance from the latter point of about one and a half inches a wound rather more than two inches long is made, crossing this line downwards and inwards. Or the incision may be placed parallel to the outer third of Poupart's ligament and from half to one inch above it.

The aponeurosis of the external oblique is exposed and incised for about two inches, cutting parallel with its main fibres, that is downwards and inwards. The internal oblique and transversalis are incised, or rather their fibres are separated in a line nearly at right angles to the incision made through the external oblique. It is important to divide as little of these muscles as possible. It is convenient to catch the edges of the opening in each muscle with Wells' forceps. The transversalis fascia, subperitoneal fat, and peritoneum are then cut through. The forceps are now transferred to the cut edges of the peritoneum, and the surgeon proceeds to find the sigmoid flexure. It often happens that the first loop to present is small intestine. In this case it should be pushed inwards. The great omentum should be treated in the same way. The operator, working across the iliac fossa, recognises the sigmoid by its being bound to the former by its meso-colon, and draws the loop into the wound. Confirmation of its nature is obtained by seeing the longitudinal bands and appendices epiploicæ. The surgeon at the same time may gain valuable information with his fingers as to the size of the obstruction, the extent of the growth, etc. Of course the operation should not be completed unless he is sure that the site of obstruction lies below the part of the sigmoid which he proposes to open.

The loop must be drawn forwards into the wound, so that the whole circumference of the gut lies outside the peritoneum. This is nearly always practicable, unless the meso-sigmoid be abnormally short. The loop should be followed upwards until the highest convenient part is secured, the rest being returned into the abdomen.

The next step is to fix the loop in position. This may be effected in one of two ways. The simpler consists in passing a wooden or ivory rod, three or four inches long, through the meso-sigmoid from side to side; the rod then rests on the abdominal wall and prevents the intestine being retracted. A stout rubber catheter or piece of drainage tube will serve the same purpose. Hartmann recommends a strip of gauze, which is passed through

the mesentery. He states that he has used it in upwards of thirty cases, with satisfactory results. One drawback to the use of gauze is the difficulty with which it is removed.

The other method, which is almost as good, consists in passing a mattress suture of silk through the skin and muscular edge on one side, then through the mesentery, the other muscular edge, and back again. The suture is then lightly tied. This double loop of suture may be tied over a small piece of rubber tube on either side of the wound, so as to prevent it from pressing too much on the skin. Moynihan describes this as "Ward's suture." Whichever method be employed, two sutures should be inserted to secure the sero-muscular coats of the bowel to the skin. Care should be taken to replace any piece of omentum that may protrude, and the stitches just mentioned will tend to the avoidance of this accident when the patient strains or vomits after coming round from the anæsthetic.

The surgeon now decides whether or not to open the intestine at once. (1) If there has been no distension of the abdomen before the operation, the opening may be deferred for three or four days. In that case soft sterile gauze is packed round and over the protruding loop, and a pad of cotton wool kept in position outside this by a bandage or binder. The nurse should be warned to apply hand pressure upon the dressings if the patient strains or is sick after the operation. This is of course to prevent protrusion of omentum or intestine alongside the loop of colon. A moderate dose of morphia or an opiate should be given the same evening if there is pain or restlessness. At the end of three or more days the intestine will adhere firmly to the wound and may be opened without giving an anæsthetic. The rod or gauze which supports the loop should be removed. A tenotomy knife is useful for puncturing the coats of the bowel, the incision being enlarged to the requisite extent by narrow-bladed scissors. If redundant intestinal wall be cut away, the arteries bleed freely, and should be clamped with forceps or tied with silk. The intestine seems to project unduly for a time, but eventually settles down.

(2) If it be decided to complete the artificial anus whilst the patient is under the anæsthetic, a Paul's tube of suitable size should be inserted. On the convexity of the intestine a purse-string suture of silk is placed, circumscribing an area of, say, an inch in diameter. In this area a linear opening is made, the edges are held aside by fine-toothed forceps, and the glass tube is introduced. The tube is so placed that its lumen is directed upwards, and the silk suture is firmly knotted round the groove on the tube (*see* Fig. 87). A soft rubber tube, some few feet in length, has been already fixed to the other end of the glass tube, through which the intestinal contents may pass into a covered jar containing a disinfectant. Or the rubber tube can be dispensed with — it tends to pull the glass tube out of place. In this way the wound can be kept absolutely clean and the neighbourhood of the patient free from odour until the tube comes away after a few days have elapsed. The insertion of the glass tube, which should be large enough to allow fæcal matter to pass along it, may be effected so quickly that no leakage occurs before the silk is tied. The tube is supported in position by a thick pad of gauze and wool around it; this dressing is held in place by a bandage. A cradle is used to keep off the weight of the bed-clothes, and the rubber tube may be conveniently attached to the side of the cradle and so carried out of the patient's bed.

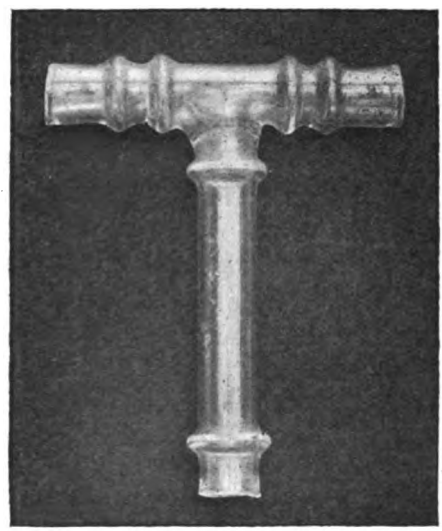


FIG. 87.—PAUL'S GLASS TUBE.

For colotomy a tube is usually employed having the shape of a capital L rather than a T.

Provided the tube does not get blocked, it may be left to come away by itself, which usually happens four to eight days after its insertion.

Whether the opening has been immediate or deferred, and whethe a Paul's tube be used or not, the result is the same in a week's time. Constant care is required to remove the escaping fæcal matter, to prevent its becoming too fluid and irritating, and to keep the surrounding skin as clean as is possible in the circumstances. The diet should be regulated in the direction of procuring solid motions, and lanoline, thymol jelly, or hazeline cream used after each cleansing of the artificial anus. The lower end of the bowel may require to be washed out from time to time through a soft rubber tube, and, if necessary, small enemata can easily be given through the upper opening.

Many forms of apparatus have been devised for colotomy patients to wear, but the simplest ones are the best. Those with large vulcanite plugs for the opening are most unsuitable. A pad of lint secured by a bandage is often found to be the most convenient and least irksome.

If the bowel has been brought well into the wound and fixed there by one of the methods described, and if the opening into it is made large enough, there will be little risk of the latter contracting subsequently to any serious extent. It is very different in the cases now to be referred to.

Modifications and Complications of the Operation.—*Scanty Sigmoid Meso-colon.*—Now and then the sigmoid mesentery will be found to be very scanty, so that it is impossible to bring the loop well into the wound. The old method of multiple sutures, described in former editions, may then be employed. A suture is made to secure the selected portion of gut to the upper and lower ends of the wound. This suture passes through the outer coats only of the bowel, and a good hold may be secured by inserting it through a longitudinal band. The peritoneum may be united to the skin at four points of the wound, but this is by no means necessary. A number of silk sutures are then inserted through the edge of the skin and muscle wound, and

then through the outer coats of the intestine, one longitudinal muscular band being utilised for this purpose. The bowel is now ready for the insertion of Paul's tube; or the opening may be deferred for some days. If the latter course be adopted, it is well to mark the point for the incision by a temporary loop of ligature passed through the outer coats; otherwise, with the altered appearance of the gut, some difficulty may be found in entering its lumen.

The tension on the meso-sigmoid is occasionally so great that the stitches tear through. In one case I (J. H.) knew this occur twice; the third attempt at fixing the sigmoid succeeded, and a satisfactory artificial anus was obtained. Had the bowel been opened on the first occasion, the patient would undoubtedly have died of peritonitis. In such cases the colon should be fixed only to the peritoneum or muscles and not to the skin, whilst if this is impossible it is best to open the transverse colon in the middle line or after closing the wound in the groin, or a left lumbar colotomy may be performed.

Excision of Tumour with Colotomy.—Occasionally it happens that a tumour is found to surround the sigmoid flexure at a point easily accessible through the parietal wound. If the loop can be brought outside the latter it should be fixed there, the opening of the gut being deferred for a few days. With or without an anæsthetic the involved portion may then be excised, and a few sutures inserted to fix the ends. Mr. Bryant has recorded a successful instance of this proceeding in lumbar colotomy.

Prolapse of Great Omentum.—This troublesome accident is likely to occur if the operator dispenses with sutures and relies on the peg passed through the mesentery. When the patient strains, omentum or even small intestine is very apt, during the first twenty-four hours after the operation, to find its way into any chink left between the sigmoid and the wound edges. Hence additional sutures, besides the mesenteric ones, should invariably be employed, and, as stated, the division of the abdominal muscles should be as limited as possible.

What should be done if the Sigmoid Flexure is found to be empty

and contracted?—Malignant stricture of the large intestine is by far the most common in the rectum and the sigmoid flexure; it may, however, occur in any part of the colon, nor is it possible always to decide its position until the abdomen is opened. In a case of obstruction in which the operator has made the incision for inguinal colotomy and then finds the sigmoid empty and contracted, he should on no account open this part of the intestine. Through a fresh incision in the upper part of the linea alba he should explore for the site of obstruction. If it is found at the splenic flexure, an artificial anus should be made in the transverse colon; if in the ascending colon, the cæcum should be opened, etc. The methods are practically identical with left inguinal colotomy. In many of these cases, however, the difficulty can be well met by abandoning the colotomy and making an anastomosis or short circuit.

Should the Distal Portion of Intestine be closed?—Surgeons from time to time have advocated the complete closure of the intestine below the artificial anus but above the obstruction. This is, however, neither a safe nor a satisfactory measure. Between the opening and the stricture possibly a length of many inches of intestine exists, in which retention of secretion may give rise to serious results. Provided a good spur is obtained, fæcal matter will not pass on into the lower segment, and with this the surgeon will be wise to rest content.

Narrowing, or the Occurrence of Prolapse at the Artificial Anus.—Unless the bowel has been brought well forward so as to make a good spur, the aperture will very probably contract within the next few weeks. Digital dilatation is, as a rule, sufficient; but if a firm scar has been allowed to form, it must be nicked in two places with a bistoury and stretched with the fingers or dressing forceps.

A not infrequent result is prolapse of the intestinal wall, especially if the abdominal wall be flabby or the opening be made too large in the muscles. This prolapse after colotomy is to some patients a most serious drawback. It can be remedied to some extent by the use of a belt and rubber pad; now and

then it will be worth while to perform a second operation, such as cauterisation of the prolapsed part, narrowing the orifice by suture, etc.

2. LUMBAR COLOTOMY

Position.—The patient should lie upon the sound side and close to the edge of the table. A small hard pillow or sand-bag is placed under the opposite loin, so that the region to be operated upon may be brought well into view, and the space between the crest of the ilium and the last rib extended to the utmost (Fig. 88).

Operation.—*First Stage.*—The incision should be from three to

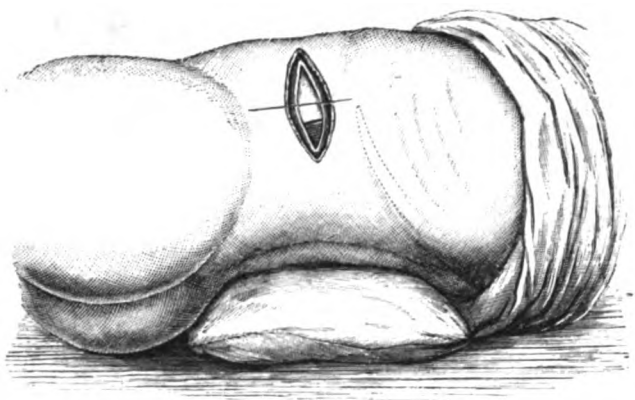


FIG. 88.—THE INCISION IN LUMBAR COLOTOMY. (The quadratus lumborum muscle is exposed.)

three and a half inches in length. It is placed obliquely, midway between the last rib and the iliac crest. Its centre should correspond to the centre of the line marking the site of the bowel. This line, as shown in Fig. 89, runs vertically down from the tip of the last rib to a point on the iliac crest half an inch behind the middle of the latter, measuring from the anterior superior spine backwards.

The anatomy of the operation is illustrated in Fig. 89.

After the skin and superficial structures have been divided the external oblique and latissimus dorsi muscles will be exposed. The fibres of those muscles are in this situation vertical. They should be divided by a single clean cut through the whole length of the incision.

The layer of the internal oblique will next come into view. The

fibres are found running somewhat obliquely upwards and forwards. This muscle is also cleanly divided through the whole length of the original wound. In the posterior part of the wound the fascia lumborum will probably come into view.

There are now exposed a few of the hindermost fibres of the transversalis muscle, which are nearly transverse in direction, and the fascia

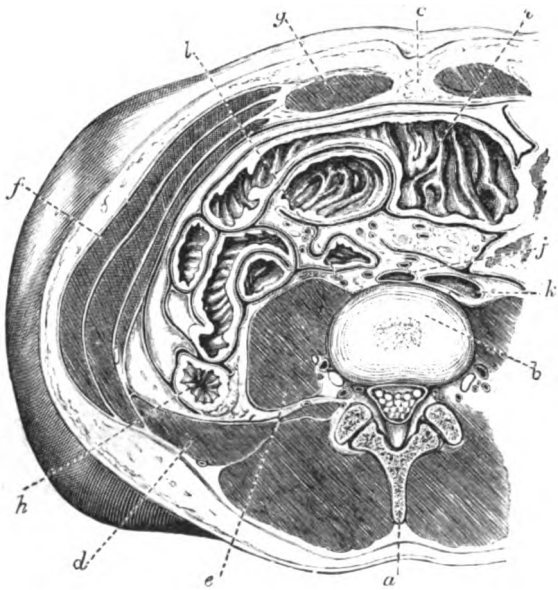


FIG. 89.—HORIZONTAL SECTION THROUGH THE BODY AT THE LEVEL OF THE UMBILICUS. (*After Braune.*)

a, Spine of the fourth lumbar vertebra; *b*, Disc between the third and fourth vertebræ; *c*, Umbilicus; *d*, Quadratus lumborum; *e*, Psoas; *f*, External oblique, with internal oblique and transversalis muscles beyond; *g*, Rectus; *h*, Descending colon; *i*, Transverse colon; *j*, Aorta; *k*, Inferior vena cava; *l*, Ureter.

lumborum. If the incision has been made as described, the actual amount of muscle tissue exposed in the depths of the wound will be slight.

The muscle and the fascia are now divided to the full length of the wound. Before this division is made it will probably be noted that the twelfth dorsal nerve, accompanied by the abdominal branch of a lumbar artery, is crossing the area of the operation. It is as well to avoid cutting the artery.

In the posterior part of the incision the clear anterior border of

the quadratus lumborum will be seen (Fig. 89). The fibres of that muscle seldom, if ever, need to be divided. Broad rectangular retractors will be found very useful at this stage of the operation.

A little fat may now come into view, and be mistaken for the subperitoneal tissue. It is the fat beneath the transversalis fascia.

This fascia must be sought for and demonstrated, and cleanly divided to the full length of the wound. It is well to commence the division close to the outer border of the quadratus lumborum.

The subperitoneal fat is now reached, and the first stage of the operation is completed.

The chief error in this stage of the operation is due to the ignoring of the transversalis fascia and the failure to divide that structure completely.

Second Stage.—The gut is now sought for. When great distension of the abdomen exists, the colon very frequently bulges at once into the wound as soon as the tissues around it have been freed by the finger.

Failing such an appearance, the fore-finger is introduced into the subperitoneal tissue and the colon is sought for. The finger follows the anterior surface of the quadratus lumborum, and seeks for the angle which exists between this muscle and the psoas.

It is towards this angle that the nonperitoneal surface of the colon faces in cases where no meso-colon exists. In seeking for this part the lower end of the kidney will be felt, and it must be remembered that the bowel lies on a plane anterior to it.

It is essential that the subperitoneal fat be well opened up with the examining finger or fingers. The exposure of the undistended bowel is impossible unless this be done.

In corpulent subjects an immense thickness of tissue will have to be ploughed through before the colon is reached.

The bowel may perhaps be recognised in the depths of the wound by the thickness of its coats or by the presence of a scybalous mass. In such case it should be gently freed and drawn into the more superficial part of the wound for examination.

It is best not to attempt to complete the operation as an extraperitoneal one, but deliberately to make a small opening in the peritoneum. The colon can then be readily found, made free, and drawn into the wound. An ivory spigot or a rubber catheter is then passed from side to side beneath the colon, provided it can be easily drawn

into the wound, or a loop of suture may be employed as in inguinal colotomy. In either case a few sutures are used to fix the bowel to the edges of the wound; these may be of silkworm gut or of fine silk. The bowel wall must be brought up at least level with the skin, and no cavity left between its sides and the edges of the wound. For details as to opening the gut see the section on Inguinal Colotomy, page 291. If immediate opening is determined on a Paul's tube should be inserted.

In securing the bowel, it is well to avoid too many stitches, too large needles, and too thick suture material. It is well also that the opening into the colon should be, at first at least, quite small.

Comment.—The only difficult part of the operation consists in the search for the colon, when that part of the bowel does not readily present. In the great majority of cases the colon at once makes itself evident.

It is remarkable that on the right side the duodenum has been opened in mistake for the colon, and on the left side the stomach. A hypertrophied and distended coil of small intestine has, with some better reason, been opened in the place of the large gut.

If the colon has been well freed from its connections in the depths of the wound, there is no need for any special instrument for drawing the gut forward towards the skin.

The surgeon should aim at making the smallest possible opening in the colon. It can, if need be, be enlarged later.

The transversalis fascia may readily be mistaken for the peritoneum, especially where the bowel appears to glide beneath it. The recognition of this fascia is a matter of primary importance.

The bulging peritoneum may be mistaken for the bowel. This error will not happen to one who is familiar with the feel of the colon when picked up between the finger and thumb.

It must be remembered that the bowel may be empty when exposed, and this even when a cancerous stricture of the rectum is known to exist.

A very fat loin introduces a difficulty in the operation. It must be met by a free incision; by a thorough division of each layer of tissue along the whole length of the original wound, and by the use of good retractors and a good light.

When the symptoms are not urgent, the operation may be carried out in two stages (colotomy *à deux temps*). The bowel is sought for,

and is fixed to the skin by numerous superficial sutures precisely in the manner described. Care should be taken that no suture extends through the mucous lining of the bowel. The part is dressed with gauze, and after an interval of some hours, or some days, the operation is completed by opening the colon.

After-treatment.—All the skin around is well covered with lanoline ointment. A large pad of absorbent wool is placed over the artificial opening, and retained by means of a many-tailed bandage.

So long as there is a copious escape of fæcal matter, no bandage should be applied.

The pad of wool must be changed as often as it is soiled, and the exclusive attention of one nurse may be occupied in keeping the patient always clean.

When the discharge is very free, a pad of loose "tenax," covered with a layer of wool, will be found to be more convenient.

The main feature in the nursing is that the part must be kept dry. The skin should not be *rubbed* clean, but should be cleansed by a stream of warm water, which is received in a kidney-shaped tray. This method involves no more trouble and no more time than the patting and rubbing process which is carried out with innumerable pledgets of cotton wool.

After each washing, the skin is very gently dried, and is once more covered with lanoline.

If the wound were to need to be washed every fifteen minutes during the first day or so, it would certainly be better than to allow a freshly united incision to remain for an hour or more poulticed with fæcal matter.

During the first few days the patient should keep very quiet, should lie upon the back, or, if the position be altered at all, should turn over towards the wounded side. The attachments of the gut will be dragged upon if the patient lie upon the sound side.

The discharge of fæcal matter from the bowel may be delayed for hours, or even for days.

3. TRANSVERSE COLOTOMY

In order to open the transverse colon a small vertical incision is required through the abdominal wall, at or close to the median line. The colon is readily identified by its longi-

tudinal bands and its attachment to the great omentum. It is probably best not to draw the intestine out of the wound but to secure it to the edges by a number of sutures, and to insert a Paul's tube. Our experience has been that there is little tendency to prolapse in this position, but on the whole the opening here is less convenient than when placed in the sigmoid flexure or descending colon. Hence inguinal or lumbar colotomy should be resorted to whenever the obstruction is below the splenic flexure.

Opening the ascending colon is very rarely resorted to, and need not be specially referred to here.

4. CÆCOSTOMY

This operation is carried out through an incision in the right groin, exactly similar to that employed for left inguinal colotomy. No muscle fibres should be divided, and the opening into the cæcum should be as small as possible. The vermiform appendix should be made use of whenever the opening is intended to be only temporary, as for example in the treatment of ulcerative colitis.

The appendix is drawn out of the wound and its base is easily fixed by a couple of sutures. The end of the appendix is then cut off and a rubber catheter introduced. Through this the whole of the colon can be washed out daily, the fluid coming away *per rectum*. A weak solution of nitrate of silver (half to two grains to the ounce of water) may be used with advantage for irrigation. So long as blood or slime is mixed with the discharge this irrigation is kept up, and this treatment may take a few weeks. Finally the rubber tube is dispensed with, and the appendix is freed from its new adhesions, and either excised or dropped back into the abdomen after careful closure of the end. As ulcerative colitis is prone to relapse, a repetition of the treatment may possibly be required; it is hence advisable not to excise the whole appendix, but to return a stump at least an inch or two long. If the appendix is employed in the manner described instead of a direct opening into the cæcum, there will be no escape of irritating intestinal contents.

RESULTS AND MORTALITY OF COLOTOMY

When performed for cancer of the rectum or intestine the result of inguinal or lumbar colotomy is usually the following: The patient is in fair comfort for one or two years, when secondary growths carry him off. The direct mortality of the operation is almost nil provided it has not been deferred until almost complete obstruction with abdominal distension has supervened. In such circumstances the death-rate is from 20 to 30 per cent.

When performed for non-cancerous stricture the results are of course far better. For example, we performed inguinal colotomy on a woman with dense fibrous stricture of the pelvic part of the rectum. For ten years since the operation she has enjoyed good health, has married and borne children! Patients with a colotomy opening are often able to attend to their business without anyone being aware of their infirmity, provided they avoid undue laxity of the bowels. On the other hand, it must be admitted that in some cases the amount of relief afforded by colotomy (for cancer) is disappointing. The pain or discomfort caused by the growth may be but little relieved, and the artificial anus may be the cause of additional distress. Before the surgeon resorts to colotomy it is his duty to put these considerations before his patient.

CHAPTER X

THE OPERATIVE TREATMENT OF ACUTE INTESTINAL OBSTRUCTION

THE various causes of intestinal obstruction can only be briefly alluded to here, and the reader may be referred for their discussion to Treves' "Intestinal Obstruction." It is, moreover, impossible here to describe all the details of operative treatment which may have to be carried out in certain cases.

The subject involves the indications for operation and the proper selection of a mode of procedure, rather than any definite or quite special surgical method.

In the account that follows, no more is attempted than an indication of the general lines upon which the operative treatment of intestinal obstruction is conducted.

Purpose of the Operation.—It must be assumed that in speaking of intestinal obstruction reference is made principally to the acute or subacute forms of that affection. In chronic forms of obstruction a definite treatment can be carried out with greater precision : the diagnosis is usually more accurately made ; there is less urgency ; there is an absence of violent symptoms, and any proposed operation can be performed with deliberation.

In the acute cases the progress of the trouble is often terribly rapid, the symptoms are violent, the need for immediate relief is very urgent, and symptoms which in a chronic case may assist the diagnosis are probably masked by narcotics.

Many cases when seen by the surgeon are seen too late. Laparotomy for intestinal obstruction is regarded by some as literally a "last resource," and the patient is not considered to be ready for operation until he is *in articulo mortis*. In not a few instances the previous treatment has compromised the success

of any interference by operation. The engorgement of the bowel has been increased by aperients, and the normal reflexes have been impaired or annihilated by excessive doses of opium and belladonna.

Operative treatment, to be successful, must be carried out early. The abdomen should be opened as soon as the diagnosis is reasonably clear. Operation should be regarded as the first and only resource, just as it is in the case of a strangulated hernia.

The risks which attend delay, and the dangers which attend uncertainty, are infinitely greater than those which belong to the mere opening of the abdomen in the median line.

In the carrying out of an operation the surgeon will have two purposes in view—(1) the relief of the dangerously engorged bowel above the occluded part, and (2) the removal of the cause of the obstruction.

In many cases the attainment of the second object will include the first, but this is not so in all.

The belly may be opened in an advanced and acute case, a simple band may be at once discovered and divided, and the abdomen closed. The case may appear very simple and very fortunate. The cause of the obstruction is removed, it is true, but the greatly distended and engorged bowel above the site of the divided band is not necessarily relieved.

It is filled up to the very stomach with a foul and fæculent fluid, by which the patient is being poisoned. The gut is paralysed, the normal reflexes are lost, there is no peristaltic wave to free the many bends and twists which must be undone to secure a free passage, and the patient dies with some pints of the foulest and most putrid matter still lodged in a viscus possessed with an instinct to absorb its contents.

In such a case as this it is not the removal of the band which is the most urgent matter; it is the complete evacuation of the engorged bowel.

It is well in the acuter forms of intestinal obstruction to bear in mind that the patient is not dying because a band or an adhesion presses upon the bowel, and that it is not the cancerous

stricture which has become suddenly blocked up that is of itself bringing about death ; but that the urgency depends rather upon the extreme engorgement of the bowel above the site of the obstruction.

It is obvious that the two conditions cannot be logically separated, but at the same time it is essential to recognise that the surgeon's first object should be rather to relieve the obstructed bowel than to remove the cause of the obstruction ; and it must not be forgotten that the attainment of the latter purpose may not be followed by the attainment of the former.

There are cases, however, where another element may predominate, and these are represented by instances in which a vast peritoneal surface is implicated in the obstructive lesion. Such are volvulus of the sigmoid flexure and cases of obstruction by bands where the constricted bowel is represented by many coils, and, indeed, by many feet of intestine. In such examples death may follow apparently from the extensive peritoneal lesion before a period at which it becomes evident that the engorgement of the bowel above the obstruction is a predominating feature.

Still, in spite of what may be urged as exceptions, the facts remain that laparotomy in acute intestinal obstruction is attended by a terrible mortality, and that the best results so far have followed in those cases in which the contents of the distended bowel have been evacuated. As Mr. William Taylor states in an excellent review of the subject, the present mortality following (but not caused by) the operation is not far short of 60 per cent. From the clinical point of view he divides the cases (*Brit. Med. Journ.*, Oct. 5th, 1907) into three groups, the treatment differing in each.

1. The patient is seen early, before there is any material distension of the abdomen. A general anæsthetic should be given, the abdomen should be opened, and the cause of obstruction found and removed. The abdomen is closed without opening the intestine, and the stomach washed out from above.

2. The abdomen has become distended, but the general condition of the patient is still good. The same course is adopted as in group 1, with the addition that the intestine above the site of obstruction is emptied through a glass tube. The small wound made in its wall for this purpose may be carefully closed by a double line of sutures, but we would urge that it is frequently safer to leave a temporary fistula. The stomach should be emptied and washed out.

3. The case is seen late; not only is there great abdominal distension, but the general condition of the patient as indicated by the pulse and facial aspect is very bad. The vomit is usually copious and fæculent.

In cases of the last group there is distinctly no time to be lost. The patient's condition is such as to forbid any but the slightest operation, and the surgeon's great object is to relieve the distended bowel with the least possible disturbance of the patient.

The patient is enveloped in warm blankets, and hot bottles are placed about the extremities. The operation, such as it is, is performed as the patient lies in bed. No anæsthetic can be administered. If one be attempted, it will be noticed that the patient becomes rapidly insensible, and very often, just as the surgeon takes the knife in his hand, there is a great rush of fæcal matter from the patient's mouth and nose, and the case is at an end. Some surgeons advise the use of cocaine, injected under the skin of the abdomen. The patients, however, in these cases are not in a condition to feel much pain. They stand the cutting part well, merely whining and moaning and wrinkling the brow as the surgeon proceeds.

A mask containing a drop or two of ether may distract their attention and cover their eyes while the actual skin incision is being made, but beyond this it is not well to go.

The *operation* consists in opening the abdomen in the median line below the umbilicus and performing an enterotomy. The incision should be as small as possible—just large enough to allow one distended coil to be drawn forwards with the finger. There should be no long searching for the cause of the obstruc-

tion. Every minute is of consequence in a case such as the present.

The bowel is rapidly fixed to the parietal wound by a few sutures which do not penetrate beyond the submucous coat, and the gut may be best evacuated through a Paul's glass tube. If the glass tube is not at hand, a trocar and cannula of large size may be employed, to the end of which a long indiarubber tube is fixed. The contents of the gut are thus carried away from the wound. A way for the trocar through the outer coats of the intestine must be made with a scalpel. As the bowel is emptying itself, it may be more accurately secured to the margins of the parietal wound by a few more sutures.

The wound is treated in the manner already described.

It is most important in these cases that the stomach should be washed out. This may be done either before or after the operation. The best apparatus is a long flexible rubber tube, attached to a large glass funnel. The other end of the tube being in the stomach, some warm water is poured into the funnel and the latter depressed so as to act as a syphon. The washing-out should be continued until the fluid returns from the stomach unaltered.

This measure usually gives great relief, and the introduction of a large amount of hot water into the stomach improves the pulse and tends greatly to revive the patient. In cases both of strangulated hernia and intestinal obstruction it is probable that many lives have been saved by thorough washing-out of the stomach with hot water at the time of the operation.

In cases of obstruction which are a little less urgent some search may be made for the cause of the obstruction prior to the establishment of the artificial anus. A band may be found, and a strangulated loop may be relieved, without adding perceptibly to the danger of the operation. But the search should be rapid ; and if the site of the obstruction be not found almost at once, there should be no delay in opening the bowel.

Management of the Less Urgent Cases.—In most of such cases the patient may safely be moved from the bed to an operat-

ing table. The stomach should be washed out with hot water before the operation is commenced. An anæsthetic may be administered, but it must be used very cautiously. Enough only is required to dull the patient's senses ; and after the parietal wound has been made, enough only to restrain his movements.

In order to diminish the risk of shock during the operation (the length and gravity of which cannot be foretold) a hypodermic injection of strychnia ($\frac{1}{60}$ to $\frac{1}{30}$ of a grain) should be given. The injection may need to be repeated during, or at the close of, the operation. Spinal anæsthesia with stovaine may be employed.

The abdomen should be opened in the median line, between the umbilicus and the pubes.

The incision made should be large enough to admit the hand. Some surgeons advise a much larger incision. Kümmell recommends that the knife be carried from the xiphoid cartilage to the pubes. Such an excessive measure is obviously unnecessary ; and it is difficult to conceive a case, unless it be one of extreme volvulus of a large sigmoid flexure, where such a wound would be other than embarrassing. Other surgeons have advised a very small median wound, one of not more than two inches, or one large enough to admit two fingers. If any search for the obstruction has to be made, a two-inch incision in a greatly-distended abdomen will be found to be of little use.

When the abdomen has been opened, search is made for the cause and site of the obstruction.

It is of course useless to diagnose a case from statistical probabilities, but the following figures are worth recording. Of 100 cases of acute intestinal obstruction about 40 per cent. are caused by intussusception (these will be practically all in children), 40 per cent. from strangulation by bands, and the remaining 20 per cent. will be due to kinking of gut, volvulus, impacted gall-stones, etc. In adults it will be noted that peritoneal bands form the most frequent cause of acute obstruction.

Not unfrequently acute intestinal obstruction supervenes upon chronic, and cancer of the gut therefore comes into the causes of the former.

The entire hand should only be introduced into the abdomen after the attempt has been made to ascertain the site of the obstruction by means of the fingers alone. In stout subjects especially it may be quite impossible to do this unless the hand is introduced, and an indiscriminate and purposeless pulling about of coils of intestine is to be avoided.

When the coils of intestine are greatly distended, they must be handled with infinite care. After a by no means rough manipulation, it may be found that the serous coat of the dilated coils has been split in twenty places.

The method of making a very large incision, and of at once dragging out as much bowel as possible, has little to commend it.

As soon as the abdomen has been opened, three fingers may be introduced and the cæcum examined. If that viscus is found to be empty, the obstruction must be in the small intestine ; if it be distinctly distended, then search must be made in the colon.

In the latter case the fingers may be passed into the left iliac region, and a stricture sought for in the sigmoid flexure or upper part of the rectum ; or the empty colon below the obstruction may be detected and followed as far as is possible. In the case of colic obstruction, the operation will probably be at once completed by performing a colotomy in the median line or in the left groin. A frequent site for cancerous stricture is the rectum at the brim of the pelvis or some part of the sigmoid flexure. When it is found high up in the latter, inguinal colotomy will not answer, and the abdomen should be sewn up in front and a lumbar colotomy performed, if possible ; if not, the transverse colon should be opened. The lower down in the large intestine the artificial anus can be made, the better for the patient. One leading into the cæcum is always a cause of irritation, owing to the fluid discharges from it. Paul's tube should be used in every case if practicable.

Cases which may be classed as acute are seldom fitted for a short-circuiting operation. At the same time it must be remembered that a short-circuiting operation has great advantages over a colotomy in the matter of comfort to the patient.

If the obstruction be not in the colon, the surgeon should pass his fingers over the hernial orifices, should examine carefully the ileo-cæcal and umbilical regions, and explore as far as is possible all parts of the pelvis. The commoner forms of acute obstruction should reveal themselves after such an examination.

If the seat of the trouble be not yet discovered, search should be made in the pelvis for any collapsed coils of small intestine which may belong to the segment below the obstruction. Such coils are very often found hanging down in the pelvis, and they frequently lead the surgeon to the occluded part, if they be carefully traced.

If so far no discovery of the trouble has been made, it may at least be urged that no injurious handling of the viscera has been carried out, and it will in many cases be desirable to desist, and to establish at once an artificial opening in the small intestine.

If, however, the patient's condition be such as to justify further search, the surgeon may, in the next place, allow some of the more distended coils of the bowel to protrude. They should be received in fine sterilised towels which have been dipped in warm water. One border of each towel should be tucked under the peritoneal edge of the wound on either side. The protruding coils will then not come into contact with the skin. The escape of these coils will enable the surgeon's hand to be introduced; the further examination should be carried out as gently and as rapidly as possible.

If the cause of the obstruction still cannot be found, some surgeons recommend that *all* the floating coils of intestine should be allowed to protrude. This proceeding is hotly denounced by others, and the absurd and opprobrious term of "evisceration" is applied to it. It is of course only the small and part of the large intestine that can protrude. Although it is a serious step, which no one would think of taking except as the last resource, yet in a few cases it is emphatically the right course to adopt. In a paper on "Complete Volvulus of the entire Small Intestine

and Ascending Colon" (Hutchinson, *Clin. Journ.*, June 7th, 1907), this question is discussed from that point of view.

Another plan is to expose the whole of the free part of the small intestine inch by inch until the occluded loop is reached. As the bowel is drawn out at the upper angle of the wound, it is passed back into the abdomen again at the lower. This plan is almost impossible when there is great distension; it involves considerable handling of the gut, and much expenditure of time.

The surgeon may, moreover, proceed with his investigation in the wrong direction, and may find himself, at the end of a tedious examination, at the duodenum.

Mr. Rand (*Brit. Med. Journ.*, Dec. 22nd, 1883) has advised an examination of the root of the mesentery as a means of avoiding the last-mentioned error. The attached border of the mesentery is only about six inches in length, and it is so obliquely placed that the right layer is directed a little upwards, and the left layer a little downwards. If a loop of the bowel be drawn forwards, and its mesentery be followed backwards to the spine, it may be often possible to tell which is the upper and which the lower segment of the loop, and also to form some idea as to whether it belongs to the higher or to the terminal parts of the lesser bowel. This is usually spoken of as the method by straightening the mesentery.

In acute cases these and other very extended and time-consuming methods of searching for the obstruction can be but rarely justifiable. In chronic cases they may be appropriate enough.

After the cause of the obstruction has been found and relieved, it will in nearly every case still be wise to evacuate the distended bowel. When no special apparatus is at hand the surgeon will incise the lowest coil of gut at its convex border and through this opening empty the coils above, taking every care not to soil the peritoneal surface with the escaping foul fluid. This, however, is almost impossible to prevent, and a much better method is described on page 284. It requires only a straight glass tube with a projecting rim

at each end, one of which is secured in a thin rubber tube. A Paul's bent tube will answer almost as well. The glass tube is secured in the intestine by a purse-string suture, and no leakage can take place.

If the surgeon decides to drain the intestine for some days the tube is of course left *in situ*, and this coil fixed to the abdominal wound.

In reducing such loops of intestine as have escaped, the assistant should draw forward the extremities of the parietal wound with large blunt hooks, and so convert the opening into a slit, just as a man would hold up the mouth of a bag into which something is to be dropped. The coils are pushed back one by one by the kneading action of the fingers, which manipulate the bowel, through a large thin flat sponge when the coils are few, or a diaper towel when they are many.

If the protrusion be considerable, the whole mass of the prolapsed intestine may be covered by a warm diaper towel, the edges of which are tucked in under the margins of the abdominal incision.

This reduction of protruded coils often occupies a considerable time. If, however, the distension has been properly relieved, the process should not involve the excessive manipulation which is called for in cases of great engorgement.

All swabs, towels, sponges and lotions used during the operation should be warm, but not hot. The peritoneum is more delicate than the surgeon's skin, and will not tolerate the same degree of heat.

Special means must be taken to protect any prolapsed coils from exposure to cold.

The surgeon should not be too sparing of his incision in the parietes. It must be enlarged as required. The search for the seat of the trouble may be aided by inspection of the depths of the abdomen from time to time. In such an examination the nearest coils may be held aside with suitable spatulæ, or sponges in holders, and the margins of the wound by broad curved retractors.

Removal of the Cause of the Obstruction.—1. *Strangulation by Bands* or *through Apertures.*—Simple bands and adhesions, and large cords formed out of the omentum, may need to be divided in sections. The obstructing band should be cut short whenever possible, lest it give trouble at a future period.

When either the Fallopian tube or the appendix forms an obstructing band, an attempt should be made to free the bowel by traction, or by breaking down or dividing the adhesions which hold the organs in place. Failing this, the parts must be severed. It may be noted that, after a strangulation under the appendix has been relieved by simple reduction, death has occurred from gangrene of the little tube itself. In any case in which the appendix is involved that process should be excised.

The Fallopian tube may be treated as a simple band, and divided between two ligatures.

The appendix, after it has been cut across close to the cæcum, should have its proximal end closed by a double row of sutures —a continuous suture involving the mucous membrane, and a series of interrupted sutures involving the outer coats.

Occasionally an acutely inflamed appendix forms with the great omentum a band which strangulates a loop of small intestine. For example, in a case of this kind operated on by one of us (J. H.), the two conditions, suppurative peritonitis and obstruction by band, co-existed. Recovery followed after excision of the appendix and omental band, with drainage.

Meckel's diverticulum, when met with in the condition of a band, should be divided and treated as such ; when it exists as a patent tube, its severed end should be closed with as much care as would be observed in closing divided intestine.

It is not wise to leave a long diverticulum attached to the bowel. If time permit, it should be cut short. Gangrene and perforation of this process have followed in cases where the obstruction has been relieved but the diverticulum left undisturbed. When very large, the removal of the diverticulum involves an operation of some gravity and duration, and this it may be undesirable to attempt. The larger diverticula may be

divided, and the proximal end clamped and brought into the parietal wound, where it plays the part of an artificial anus. Such an opening is more easily closed than one in the bowel itself. In such a case the distal end would be excised entirely.

The great majority of cases of strangulation by bands (70 per cent.) occur in the male sex. Nearly all those due to vitelline remains (Meckel's diverticulum, etc.) are met with in men.

Taking all cases of band-obstruction, the small intestine is involved in 90 per cent., and the right iliac fossa is the site in nearly 70 per cent. (Fitz).

In cases of strangulation through slits and apertures, it is well, when possible, to close the abnormal aperture with a few points of suture after the gut has been reduced.

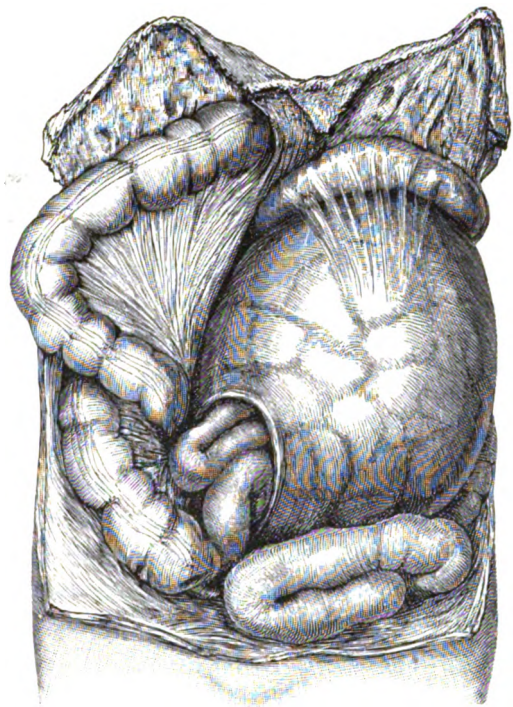


FIG. 90.—HERNIA INTO THE FOSSA DUODENO-JEJUNALIS. (*Treitz.*)

The hernial orifice is displaced to near the cæcum. The colon has been drawn aside to show the sac which contains all the small intestine.

Much difficulty may be experienced in dealing with retro-peritoneal herniæ. In a case of strangulated hernia at the foramen of Winslow, not only was I (F. T.) unable to reduce the gut through a laparotomy wound during life, but after death reduction was not effected until I had severed the hepatic artery, the portal vein, and the bile duct.

2. *Volvulus.*—In only the very simplest cases can volvulus be unfolded by mere manipulation.

No persistent attempts should be made to effect such a reduction. The huge coil formed by the distended sigmoid flexure cannot be dealt with through the comparatively small wound made in abdominal section. The involved bowel should be emptied through a glass tube in the manner already described. Its contents are mainly gaseous. The hole made can be clamped temporarily and the volvulus reduced. If the reduction be perfect, and if it show no disposition to return, the opening may be closed. Failing such evidence, an artificial anus must be established in it. I (F. T.) have found it impossible to reduce a volvulus of the sigmoid flexure on the post-mortem table until the bowel had been emptied.

It must be remembered that the reduction of a volvulus does not usually remove the anatomical condition that led to it.

In the *Clinical Journal* for June 7th, 1907, I (J. H.) have drawn attention to an important form of volvulus in which the whole of the intestine supplied by the superior mesenteric artery is twisted on its axis so that the cæcum passes under the mesentery and lies in the left side of the abdomen. Ten cases are narrated. In this form it is almost impossible to recognise the condition and reduce the twist unless the parts concerned are drawn outside the abdomen.

3. *Intussusception.*—For the *chronic* form of intussusception abdominal section is the only suitable treatment; indeed, its diagnosis is usually difficult or impossible until the abdomen has been opened.

When reduction cannot be effected by manipulation in the manner to be described, resection with end-to-end suture (or perhaps the use of Murphy's button) may be necessary. If, however, the patient be in an exhausted condition at the time of operation, it is safer to make a small artificial anus by means of Paul's tube above the intussusception, and defer the resection to a later period when the patient has regained strength. There is the less objection to making a temporary artificial anus, since

the intussusception usually affects the colon. In several cases of chronic intussusception the part has been excised in the belief that the mass was carcinomatous.

With regard to the much more frequent condition of *acute* intussusception met with in infants and children, surgical opinion in the last ten years has steadily come round to advise abdominal section at the very earliest possible moment. The mortality following reduction by this method has fallen to about 20 or 30 per cent., including the cases of young infants, in whom the condition, whether operated on or not, used to be nearly always fatal. Spontaneous recovery is so rare that it may be disregarded, and although a fair percentage may be relieved by inflation with air or water, the method is uncertain and attended with the risk of rupture of the intestine. In all cases the greatest difficulty in reduction is met with at the end—*i.e.* in the last few inches—and with inflation it is difficult to tell whether complete reduction has occurred or not. We strongly advise the immediate resort to laparotomy and reduction by digital pressure without wasting time by trying inflation. H. M. Rigby (*Lancet*, Feb. 7th, 1903), in reporting a series of seven cases treated by him with laparotomy, no less than five of which were successful, notes that in over fifty cases operated on at the London Hospital by various surgeons inflation was not found of use in a single case. All of those in which inflation or injections were tried had ultimately to be operated on. This is conclusive evidence against the recent contention by some that inflation, etc., should still be given a trial.

As a rule, it is more convenient to reduce the intussusception with the fingers, applying pressure steadily from below on the intestine, aided by gentle traction exerted on the intestine above. The younger the patient, and the older the intussusception, the greater is the risk of tearing the intestinal coat, and it is especially in the last few inches that this accident is likely to occur. Considerable help in reduction may be obtained by steady pressure on the lower end of the intussusception, so as to lessen its engorgement and swelling.

Before commencing the operation the surgeon sees to the prevention of shock in every possible way; and rapidity in its performance is of importance. As little of the abdomen should be exposed as possible, and in many cases reduction can be effected without bringing the intestine outside the wound; the patient's chest and limbs should be kept thoroughly warm by means of blankets, hot-water pillow, etc., and at the end of the operation a small rectal injection of warm water and brandy may be advisable. The site of the incision will be to some extent determined by the position of the sausage-shaped tumour, which may have been previously felt through the abdominal wall. In the vast majority of cases the intussusception has begun in the cæcal region, and the most trouble will be found in unravelling it when this part is reached. Hence, if the tumour is small and limited to the right side of the abdomen, the incision may be made in the right semi-lunar line; if the lower end of the intussusception has been felt *per rectum*, the linea alba must be chosen. It should be noted that a small intussusception may be quite hidden behind the liver of a young child, and that this condition has unfortunately led to postponement of an operation at the only time when it could have saved the patient. Should the incision be made in the linea alba below the umbilicus, the surgeon should have ascertained that the bladder is empty; as is well known, the bladder in a child is an abdominal rather than a pelvic organ. As soon as the abdomen is opened sufficiently to admit four fingers the intussusception is felt for and its extent defined. The upper end of it is steadied by the fingers of the left hand, whilst pressure is made on the lower end with the fingers of the right hand. In some cases it is difficult and unnecessary to bring the tumour outside the abdomen; in others this is readily done.

As the last few inches are unravelled the difficulty increases, and frequently the peritoneal coat is slightly torn. Any rent should be sewn up afterwards with fine silk (Lembert's sutures). The vermiform appendix is frequently the last to emerge from the invagination. In a considerable number of cases, either a Meckel's diverticulum (turned inside out) or a polypus has

been the cause of the intussusception. If possible, this should be excised through a small incision made in the length of the gut. (*See* Fig. 91, which is taken from the report of two cases operated on with success by Mr. Rutherford Morison, *Lancet*, June 14th, 1902.)

In every case as soon as the intestine has been satisfactorily dealt with the abdominal wound should be sewn up as quickly as possible and the patient hurried back to bed. In few abdominal operations is speed so important a factor of success as that for intussusception in young children or infants.

If, at the operation, after many patient attempts, reduction cannot be accomplished, one or other of the following plans may be carried out :—

(*a*) An intestinal anastomosis may be effected by suture (*see* page 278). I am not aware of a single case in which recovery has followed this procedure.

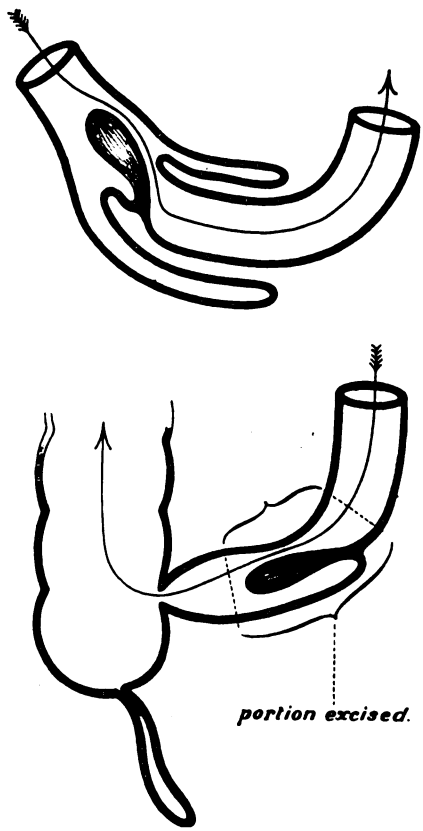


FIG. 91.—Diagram illustrating a case of intussusception caused by polypus, treated successfully by reduction and subsequent excision of the part shown between brackets (case under Mr. Rutherford Morison), copied from Mr. Morison's paper, *Lancet*, June 14th, 1902.

(*b*) The involved segment of the gut may be resected and an artificial anus established. This measure is of limited application, and could hardly be advised in a case where the invagination is extensive.

(*c*) The establishment of an artificial anus without resection.

This measure would appear to be recommended in irreducible cases where resection is contra-indicated and where time is pressing. It cannot claim to possess, on *a priori* grounds, any advantages over the first method named.

(*d*) The resection of the intussusceptum, and the immediate restoration of the canal by suture of the divided ends of the bowel. This method is theoretically the best, but it has been attended with a heavy mortality. Kocher reported five successes, Rydigier three out of twelve collected cases. On the other hand, Braun, Wiggin, and Barker record in all some twenty cases, every one of which proved fatal.

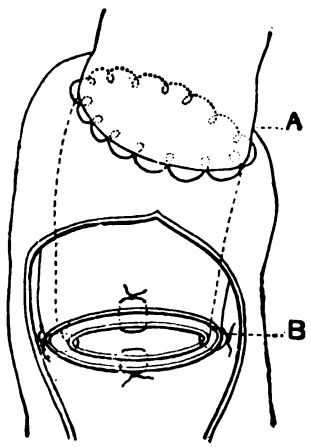


FIG. 92.—BARKER'S OPERATION FOR IRREDUCIBLE INTUSSUSCEPTION.

A, Continuous suture at neck of the intussusception; B, suture of the divided layers of bowel after excision of the intussusceptum. (From *Annals of Surgery*.)

(*e*) The following measure, devised by Mr. Barker, appears to offer the best prospects of recovery and has so far been attended with the best results. The principle of the operation is the excision of the intussusceptum through a cut made in the intussuscipiens.

At the neck of the invagination —*i.e.* at the point where the sheath receives the entering layer —the two portions of bowel are united by a continuous suture of fine silk (Fig. 92, A). This suture takes up the serous and muscular coats, and is carried on to the mesentery. If there be any sign of gangrene about the neck, more gut is invaginated before the suture is inserted. A longitudinal incision is then made through all the coats of the intussuscipiens along its free margin or convex side. The intussusceptum is thus exposed, is drawn out through the incision made in the sheath, and is entirely divided as near as possible to its upper end. This involves, of course, the division of two layers or rings of bowel. Stout silk ligatures are passed through all the walls of

the stump, and are tightly tied so as to keep the serous surfaces in contact and to control all bleeding from the vessels entering at the mesenteric attachment (Fig. 92, B). The earlier sutures are introduced before the section of the bowel is complete. Indeed, as soon as a convenient portion of the intussusceptum has been divided, the two cut layers of gut, which are thereby exposed, are secured by silk sutures. From four to six sutures will suffice for this part of the operation. The last of the sutures includes the stump of the mesentery, which is not divided until the suture has been tied. Care should be taken to see that the lumen of the intussusceptum is clear. The stump is cleaned and dried, and dusted with iodoform. It is then allowed to drop back through the incision into the lumen of the intussuscipiens. The longitudinal incision in the latter is now closed, and the abdominal wound adjusted by sutures. If there be any suspicion as to the state of the gut at the site of the operation a gauze drain may be introduced. If the intussusceptum cannot be drawn out through the cut in the sheath it must be divided *in situ*, and the securing of the stump proceeded with. In a case of Leszczynski's the amputated intussusceptum could not be extracted, and it was left to be passed with the stools. Many modifications of this operation have been devised, but they are of little moment, and appear to offer no material advantages over the original operation.

Note on After-treatment.—Feeding by the mouth should be begun as soon as possible after the operation. Small doses of tincture of belladonna have been recommended to prevent recurrence during the next few days.

Results of Operation for Intussusception.—Individual statistics published by many observers—F. S. Eve, B. Pitts, C. Wallace, C. H. Fagge, W. Taylor, H. M. Rigby and others—vary considerably. This chiefly depends on the fact that one surgeon may meet with a number of irreducible cases, another may escape them entirely. Probably it is correct to put the mortality of the operation at about 30 per cent., and perhaps rather higher.

A word of caution as to the healing of the abdominal wound in young children may be given. On no account should the sutures

be removed before a full fortnight has elapsed. Union is slow in these subjects, and now and then the wound has burst open at the end of ten or even more days if the stitches have been removed.

In chronic colic invagination into the rectum the invaginated part has been resected with success. Failing this, attempts at reduction having already proved abortive, colotomy may be carried out.

4. *Foreign Bodies.*—In the case of some foreign bodies, *e.g.* gall-stones and the softer form of enterolith, it may be possible to break up the substance or to crush it without opening the intestine. In one case recorded by Mr. Clutton an impacted gall-stone was successfully pushed through the ileo-cæcal orifice. As a rule, however, it is impossible or unwise to carry out either of the above methods, for the following reason :—

The bowel at the site of impaction will most probably be inflamed, the mucous membrane may be deeply ulcerated, or the coats of the intestine may be passing into a condition of gangrene. No attempt should therefore be made to disintegrate the calculus at the seat of impaction. The surgeon should endeavour to displace it upwards into the distended but healthier bowel above the obstruction, and deal with it there. Failing this measure, the foreign body may be removed by an incision made on the free border of the bowel and in its long axis. This incision also should be made through healthy intestine, and not directly through the gut at the seat of impaction. It is usually more convenient to make the incision in the dilated bowel above the obstruction.

The question of closing the incision in the gut at once by sutures, or of establishing an artificial anus, must depend upon the state of the intestinal wall at the seat of the impaction, and upon the degree of engorgement of the canal above that point. If the gut is healthy but distended, the coils should be emptied of their contents through the wound, taking care not to soil the adjacent intestine ; the wound should then be sewn up with a double row of fine silk sutures. It should be remembered that gall-stones in the intestine are sometimes multiple.

If the gut be gangrenous at the seat of the obstruction, the part involved should be resected and an artificial anus established.

The stomach should be washed out before the patient comes round (if an anæsthetic has been used, which is not always advisable). Strychnia should be given hypodermically, and stimulants employed with a liberal hand. The subjects are usually old and in a deplorable condition from the constant vomiting, hence shock is severe, even though the operation be quickly performed. In one of our cases after removal of a calculus from the ileum the patient, an old woman, was unconscious and apparently moribund for three days, ultimately making an excellent recovery. The danger of shock and peritonitis following the operation may be estimated from the combined statistics of Kermisson, Rochard, and Dagron—124 cases of operation for impacted gall-stone, only 38 recoveries : *i.e.* 30 per cent.

Other Forms of Obstruction.—Under this heading may be included in a general way varieties of obstruction due to causes which are less easily dealt with than those hitherto mentioned. In this category may be placed stricture, matting of adjacent coils of bowel together by many adhesions, direct compression of the gut by contracting adhesions, some complex forms of volvulus, and other allied conditions.

In these cases (*a*) an artificial anus may be established, and nothing more attempted. Such a procedure would be adopted for the more urgent and the more complex cases. (*b*) The involved part of the bowel may be resected and an artificial anus established. This measure may be advisable in cases of stricture, and in other instances where the resection can be carried out with ease and completeness. (*c*) Resection may be followed by immediate suture of the divided bowel. There is very little to be said in favour of this method in cases where any degree of obstruction exists. (*d*) The involved parts may be left undisturbed and an intestinal anastomosis established. This procedure appears to have before it a fair prospect of success.

When the involved bowel is gangrenous, resection cannot be avoided ; and an artificial opening should be established.

Results of Operative Interference in Acute Intestinal Obstruction.—Statistics dealing with this subject are apt to be somewhat misleading. The general mortality which is to be adduced from the various published tables is without doubt lower than that met with in actual practice, and does not represent the actual death-rate. It may be inferred that the majority of the successful cases are published, but that a very large proportion of the fatal cases are left unrecorded. In "Intestinal Obstruction" (1899) I (F. T.) estimated the percentage of recovery after operation in all the forms of intestinal obstruction taken together at about 50 per cent.

Among the examples which would be reckoned as ending favourably are not a few which were—to judge from the published accounts—not instances of acute intestinal obstruction at all, but were examples rather of peritonitis. In such cases "much effusion into the peritoneal cavity" is reported, adhesions are encountered, and the cause of the imagined obstruction is not uncommonly ascribed either to adhesions or to volvulus of the small intestines.

One of the best collections of cases is that published by Dr. Curtis in the *Annals of Surgery* for May, 1888. He deals with the results of laparotomy in intestinal obstruction since 1873. In a total of 328 cases there are 226 deaths and 102 recoveries —a mortality of 68·9 per cent.

It is made evident that this failure of the operation was due directly to the unfavourable condition of the patients; some were in a dying condition, others were exhausted, in many gangrene of the bowel was advanced. Dr. Curtis's tables afford a strong argument in favour of early operation.

In 247 cases where the cause of the obstruction was removed the mortality was 62·7 per cent.; while in 74 instances in which this was not done the mortality was 86·4 per cent.

The highest death-rate was associated with cases where from any cause suturing of the bowel was carried out. The total number of such cases was 45, with a mortality of 86·6 per cent.

CHAPTER XI

OPERATIONS FOR FÆCAL FISTULA AND ARTIFICIAL ANUS

THE nature of the operation carried out in these cases will depend obviously upon the character, situation, and degree of the artificial opening.

For the purposes of classification, with a view to treatment, fæcal fistula may in the first place be divided into (A) those which involve the jejunum and ileum, and such parts of the colon as are normally provided with a free meso-colon, viz. the transverse colon and sigmoid flexure; and (B) those which implicate the more fixed segments of the large intestine—that is to say, the ascending colon, the descending colon, and the cæcum.

A. **Fæcal Fistulæ involving the Small Intestine and the Free Parts of the Colon.**—These unnatural openings may roughly be placed in four categories.

1. In one category the loss of substance in the wall of the bowel is small; the gut is not acutely bent upon itself; the orifice is small, and the opening in the skin is connected with the opening in the bowel by a sinus-like tract (Fig. 93, 1).

Such a form may be illustrated by the following case: A surgeon made an exploratory incision in the median line of the abdomen in a young woman. The cut was small, and was below the umbilicus. It was probable, from her account, that the mass which was the subject of speculation was a fæcal accumulation. It would appear also that a loop of the lower ileum was accidentally wounded and the wound at once closed—the injured intestine lying close to the parietal wound, which was also sutured. Some days after the operation the wound broke down. Fæcal matter then began to escape, and a permanent

fistula resulted, which, when I saw the patient, had been discharging for nearly twelve months. Through this opening practically the whole of the intestinal contents were evacuated, since a small motion was only passed *per anum* about once a fortnight. I closed this artificial anus at one sitting by *Method No.* 1 (page 326), and the patient made an uninterrupted recovery.

It is to this form of the trouble that Method No. 1 is especially applicable.

2. In another class of case the loss of intestinal substance has been greater, the opening is larger, and the mucous membrane

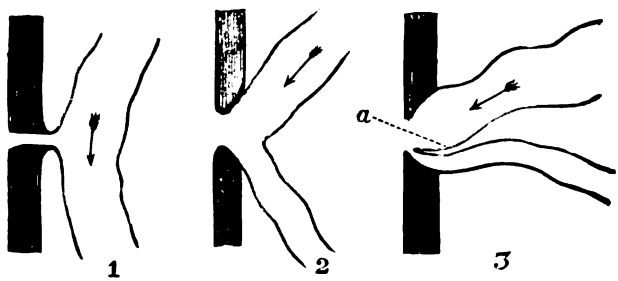


FIG. 93.—THREE FORMS OF FÆCAL FISTULA.

of the bowel is more directly in contact with the skin, and is more extensively exposed. There is no very considerable "spur," if any, separating the upper segment of the gut from the lower (Fig. 93, 2).

This form of artificial anus may be illustrated by that which is left after enterotomy, especially when followed by some sloughing of the bowel. It may result, also, after a resection, when the bowel has been partly united, and a fæcal fistula has been carefully established, with a view to a subsequent operation for closure. For this variety the procedure described as *Method No.* 2 (page 329) is applicable.

3. In a third form there has been a little or a great loss of substance. The opening is probably extensive, the two ends of the gut meet at the orifice at a very acute angle, and the lumen of the proximal segment is separated from that of the distal segment by a fold formed of the coats of the bowel at its mesenteric

border. This fold is known as the spur, or *éperon* (Fig. 93, 3, *a*). It forms a real septum, and prevents the contents of the gut from following their natural course, while it is a potent factor in the maintenance of the artificial orifice.

The treatment of this variety is considered in the section headed *Method No. 2.*

The best instance I have seen of this form was in a man who had suffered from strangulated inguinal hernia. He declined treatment. The gut sloughed, the coverings of the sac gave way, and the parts of the intestine which were concerned in the fistula were those which had formed the pedicle of the loop of strangulated bowel. This case was remarkable from the fact that, although the patient continued to prefer the nostrums of a herbalist to the uncertainty of what was termed a "necessary operation," the fistula, at the end of many months, closed spontaneously, to the gratification of the patient and the discomfiture of scientific surgery.

4. In this form a portion of intestine has been wholly removed, for example in excision of an intestinal growth, the two ends have been fixed side by side in the wound, and there is no communication between them.

B. **Fæcal Fistulæ involving Fixed Parts of the Colon.**—The most frequent of these are such as result from intentional or accidental wounding of the colon through the loin, and such as follow suppurative appendicitis. The abnormal opening will, therefore, be usually found either in the right iliac region or in the left loin.

So far as its characters are concerned, it will most commonly accord with the first of the three types mentioned above. There is a sinus, of varying dimensions, leading down to the bowel, which is comparatively deeply placed. In the right iliac region this is, perhaps, the form which the lesion will take without exception, the segment of gut involved being the cæcum.

The fæcal sinuses in the right inguinal district which result from appendicitis have a distinct tendency to undergo spontaneous cure, and of this termination we have seen many examples.

The fistulæ which are placed in the loin exhibit little of this disposition.

These colic sinuses are difficult to close by operation. The great thing needed for success in any such operation is a ready supply of peritoneum. Two serous surfaces should be brought together.

In the sinuses which result from appendicitis the bowel is commonly buried in a mass of adhesions. The true peritoneum has been lost, and little material is available to meet the requirement that, in closing the opening in the gut, two surfaces of serous membrane should be brought into contact.

The procedure adopted for the majority of these cases is that described as *Method No.* 1.

An artificial anus in the loin is also, as a rule, very difficult to close. There may be no opportunity of making a complete union by means of united serous surfaces, and the obstacles in the surgeon's way when there has been much destruction of the bowel are considerable.

Methods of Operating.—*Method No.* 1.—For some time before the operation every means is taken to put the skin around the abnormal opening in as healthy a condition as possible. The eczema which is often present may be much relieved by constant attention to cleanliness, by keeping the part dry, and by dressing it with dry boric acid powder, with boric ointment, or such other application as may seem indicated. The diet must be so regulated as to allow of the formation of the least possible amount of intestinal *débris*. By careful dieting, and by the use of such drugs as salol, moreover, much can often be done to diminish the irritating properties of the escaping matter.

The lower bowel should be well cleared by enemata.

The bowel above and below the opening should be washed out as well as possible, both before the operation and during the administration of the anæsthetic.

The opening leading to the bowel is now plugged with non-absorbent cotton wool. An elliptical incision is made in the skin. This incision will circumscribe the abnormal orifice, and will

include the skin immediately around it (Fig. 94). This skin is seldom healthy, and the surgeon can well afford to sacrifice it. The long axis of the ellipse will be placed as is most convenient. When in the median line it will be vertical; when in the iliac region it will probably be oblique. The sacrifice of skin should be liberal. The lateral parts of the cut (*d* and *c*, Fig. 94) are cautiously deepened till the peritoneum is reached, and the peritoneal cavity well opened.

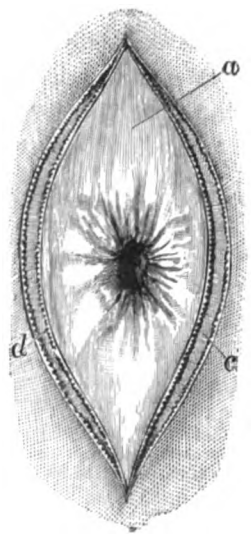


FIG. 94.—METHOD OF CLOSING AN ARTIFICIAL ANUS.

a, Eczematous skin around fæcal fistula; *d*, *c*, Skin wound.

A portion of a gum-elastic bougie is introduced into the artificial anus, and made to serve as a guide.

There is often difficulty in clearly opening the peritoneum on both sides. It is desirable, however, that the lateral incisions (*d* and *c*) should be sufficiently wide apart to render it probable that the surgeon is clear of the adhesions which surround the sinus. The utmost caution must be observed in opening the abdomen, as a coil of adherent bowel may easily be cut into.

The tip of the finger is introduced through one of the lateral cuts, and the part explored. The position of the gut can be made out, and, if it be not closely adherent to the abdominal wall, the tract of the sinus can be traced.

The skin wound is now deepened all round, and, guided by the finger which is introduced into the abdominal cavity, is carried throughout through the peritoneum. There is thus isolated a little oval island, made up of the tissues of the abdominal parietes. Owing to the retraction of the skin, the actual sacrifice of muscular and aponeurotic tissues is small, and the parts concerned are usually found to be so modified by inflammation and atrophy that little normal-looking muscle tissue comes into the

isolated patch. The tissues of the parietes about the abnormal opening are, as a rule, much altered, and such as are sacrificed can probably well be spared.

The bowel is now liberated as far as possible, and is drawn into the wound with the island of skin attached to it. Sponges are wedged in around the bowel, to prevent the entrance of any fæcal matter into the peritoneal cavity. The surgeon now isolates, as well as he can, the mass of adhesive tissue which binds the gut to the parietes. This he does without opening the sinus, the position of which is indicated by the bougie.

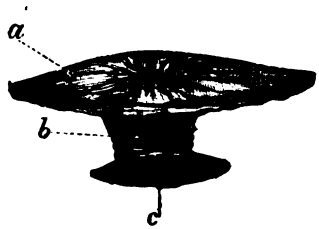


FIG. 95.—METHOD OF CLOSING AN ARTIFICIAL ANUS.

a, Skin with fæcal fistula; *b*, Tissues around the sinus; *c*, Bowel with internal orifice of the sinus.

The gut is clamped above and below by the fingers of an assistant. A small elliptical piece is excised from the intestinal wall. In the centre of this ellipse will be the orifice into the gut. The long axis of the ellipse will coincide with that of the bowel. The parts are cleaned, and the gap made in the bowel is closed by a double row of sutures. The edges of the parietal wound are also united by sutures.

In the case of a deep sinus—such a one, for example, as may be met with in the iliac region leading to the cæcum—it is often possible so cleanly to divide the tissues around the sinus as to remove the diseased parts in a single piece, which will have the outline and arrangement shown in Fig. 95.

When a sinus burrows or follows a devious course, or is double, then this operation cannot be carried out without an accidental opening of the fistulous passage.

It is well, however, that the ill-conditioned inflammatory tissue in which the sinus is, as it were, buried, should be removed by dissection and scraping.

Above all is it essential that the abdomen should be opened clear of all adhesions, and that the bowel to be dealt with should be approached through normal peritoneum.

In certain of the numerous cases in which we have operated upon fæcal fistulæ due to appendicitis we have first opened the abdomen in the median line so as to be able clearly to explore the involved bowel without being hampered by adhesions. The operation for closure has been carried out by another incision at the seat of the sinus as above detailed, but from time to time the median wound has been used to guide the steps of the operation. In no circumstances should any attempt be made to close the fistula by dealing with the sinus. The sinus must be ignored, and the seat of the bowel lesion approached through the free peritoneal cavity.

Method No. 2.—The patient is prepared in the manner already described, and the skin around the opening is placed in as healthy a condition as possible. The bowel is lightly plugged. The integument is excised by means of an elliptical incision, and the isolated part of the parietes thus defined is entirely removed before the conclusion of the operation. The abdomen is opened as in the previous operation. The involved loop of bowel is freed from adhesions as far as is necessary, and is drawn forward, together with the oval isolated piece of the parietes which still adheres to it.

The intestine is clamped above and below, either by a clamp or by the fingers of an assistant, the plug of wool is removed, and as much of the gut is excised as is necessary. (*See* pages 257-260.)

After the resection the divided ends of the intestine are united by suture in the manner described in a previous section (page 258).

In resecting the intestine it is of the greatest service if the continuity of the bowel can be left undisturbed at the mesenteric margin. The suturing of the bowel is carried out over a bone bobbin, which is peculiarly useful in these operations. Indeed, in no intestinal operation is the bobbin more valuable.

After the bowel has been united, the wound in the abdominal parietes is closed by sutures in the usual way. It is to be remembered that the lower segment of intestine will be much narrower than the upper.

The resection is carried out upon the lines already laid down.

Fæcal fistulæ of the third type—*i.e.* those in which a very marked spur exists—are best treated by Method No. 2, a bone bobbin being used in every instance. Some surgeons, however, in dealing with this type of fistula concern themselves only with the removal of the obstructing spur or *éperon*. After the removal or obliteration of that fold, spontaneous closure of the artificial anus has, it is said, followed.

The simplest method appears to consist of introducing a substantial piece of thick indiarubber tubing into the two orifices of the bowel. The tube tends to straighten itself, and, as a consequence, the bowel also; it presses at the same time upon the *éperon*, and encourages its removal by displacement and absorption. A piece of silk is attached to the tubing, to prevent its slipping out of reach. Sir Mitchell Banks has obtained some excellent results from the use of this simple measure.

There is, however, no doubt that the resection operation is much more satisfactory, more speedy, and more certain.

Dupuytren's enterotome is an instrument specially devised for destroying the spur in these cases. It is a broad-clamp forceps which is made to grasp the spur and is left applied for some days, and gradually tightened until it comes away. It is still occasionally employed, but our experience of this instrument has not been favourable. It is difficult to apply it and to regulate its pressure; there is, moreover, considerable risk of causing perforation at the back of the gut, and so leading to peritonitis. Its principle is the same as Murphy's button, and most surgeons have now abandoned the use of the latter on account of its risks.

Method No. 3.—Here the two ends of the bowel are completely freed, drawn into the wound and clamped. Sufficient is excised to bring the lumen of each into even contact, and complete enterorraphy is performed by a double row of continuous suture (of fine silk). As the lower portion has usually contracted a good deal, a bone bobbin may be found useful over which to perform the suturing. Or the lower end may be gently stretched with the fingers before commencing to unite the two portions of

gut. The surgeon may choose another plan from that of end-to-end suture: he may close both and then perform lateral anastomosis, as near as is practicable to the end of the two portions (*see* page 278). This by many surgeons is considered to be the safest. Before suturing the ends of intestine a pair of crushing clamps (Doyen's) may be applied so as to break up the mucous membrane just at the line of suture. Whether this is done or not (and its value is doubtful), the operator should always place two lines of suture—the first through all the coats, the second a continuous Lembert which invaginates the first line.

When a number of sinuses lead to an extensively diseased piece of intestine the only plan is to excise all the diseased portion; it is essential to success to obtain normal or healthy ends for union. Thus Mr. Crawford Renton, in a case of multiple fistulæ leading to the cæcum, successfully excised the whole of the latter organ.

After all these partial or complete resection operations it is wise to place a small drain (gauze or spiral rubber tube) at some part of the wound, in case of a leak during the next few days after the operation. It is also well to feed the patient mainly *per rectum* for some days, allowing only water and some good meat-juice to be taken by the mouth. A few days' inconvenience of this kind should not be allowed to damage the chance of success of what is always a hazardous and somewhat uncertain operation.

CHAPTER XII

OPERATIONS ON HERNIA

THE great majority of operations on hernia are now done with the object of obtaining a radical cure. In a small proportion of these strangulation is present at the time of operation, but this fact need rarely modify the procedure to be employed.

Hence it will be best first to describe the methods appropriate to the radical cure of each form of hernia, noting any special points which arise if strangulation exist.

The comparative frequency of the different forms of hernia requiring operation will be seen from the following record of fifteen years' work. During that time I (J. H.) operated on 510 cases, in 150 of which strangulation was present. Of these 360 (70 per cent.) were inguinal, 100 (20 per cent.) were femoral, and 50 (10 per cent.) were umbilical or ventral herniæ. Probably at the present time the relative proportion of herniotomies for strangulation to those for simple radical cure would be still smaller than that given above (30 per cent.). It will be noticed that operations on inguinal hernia are more than twice as frequent as those for all other forms.

It may be added that few operations in surgery are more successful and satisfactory than those for the radical cure of inguinal hernia. This was by no means the case for some years after the operation was introduced. Successive improvements in method, and particularly in the selection and placing of the buried sutures, have in the last ten or fifteen years rendered the operation almost perfect, and left but little room for further development. At the same time it must be admitted that few surgeons operate on inguinal hernia in exactly the same method, or employ exactly the same material for their buried sutures.

Of the endless modifications it would be wearisome and useless to give even a list, but a few words may be devoted to the history of the operation.

Of the various operations devised and practised for the radical cure of inguinal hernia prior to 1850 it is not necessary to say much. Some were crude, others ingenious, most were either ineffective or barbarous. It is strange that methods which combined the two last qualities, such as the invagination of skin into the canal (Wützer's operation) or the injection of astringents " to set up plastic obliteration of the sac," should have survived many years after the date mentioned, and after the introduction of general anæsthesia had cleared the way for proper surgical procedures. It is equally strange, considering the enormous number of hernia operations now performed, and the fact that the results are amongst the most successful in surgery, that in the late Prof. John Wood's time (only some twenty-five years ago) most surgeons looked askance at the operation, and rarely if ever practised it. In 1879 a distinguished German authority denounced the operation as unjustifiable. Wood was the real pioneer of radical cure of hernia as Spencer Wells was of ovariotomy. It is true that for some time, before Lord Lister had introduced the antiseptic system, Professor Wood employed silver wire subcutaneously to narrow the inguinal canal. The wire was always withdrawn after two or three weeks. But when Lister's discoveries had rendered the open operation safe, Wood advocated methods which closely approached those now in use, dealing thoroughly with the sac and employing kangaroo tendon for the deep sutures which narrowed the canal. After Wood the names of those who have helped to place radical cure of hernia in the position it now stands are legion. Professors Kocher and Bassini, Sir Mitchell Banks, Halsted, and Sir William MacEwen should especially be mentioned. To Bassini is due the credit of having demonstrated the value of opening up the canal to the internal ring in order both to deal efficiently with the hernial sac and to narrow the canal itself. This is without doubt the most important improvement since Prof. Wood's time.

I.—THE RADICAL CURE OF INGUINAL HERNIA (PLATE XII.).

Preliminary Considerations as to the Methods Employed.—It is generally admitted that the most important step of this

operation is the obliteration of the peritoneal sac at the level of the internal ring—*i.e.* where the deep epigastric vessels pass round it. In a considerable number of cases, especially in children and young adults, where the inguinal canal is otherwise normal, this high ligature and excision of the sac will suffice to obtain a radical cure. In others where the canal has been stretched and the two rings perhaps approximated, it is advisable that in addition the canal should be narrowed by means of deep or buried sutures. Such narrowing, however, should be effected not only at the external ring, but also higher up, where a hernia first begins to protrude.

To Bassini we owe the demonstration that if the external oblique aponeurosis be slit up over the canal, it is easy for the surgeon to deal with the sac at its highest point, and to effect a narrowing of the canal by sutures which can be placed with far more accuracy and safety than if the parts are not exposed. Further, the surgeon is able, if he prefers this method, to transplant the cord forwards and completely obliterate the former inguinal canal. For these reasons some modification of Bassini's method is used by the great majority of surgeons with much experience of the radical cure. At the same time, to slit up the inguinal canal and to place a number of buried sutures deep in the abdominal wall is attended with obvious risk if suppuration should occur. If silk be employed for this purpose, it is apt to give trouble and to work out, leaving the wall of the canal weaker than it was before the operation. The thicker the silk used the greater is this risk. Kangaroo tendon, if properly prepared (it is easy to sterilise), never gives trouble, and becomes incorporated with the fibrous tissues of the part. In an experience of several hundred cases in which it has been employed for deep sutures I (J. H.) have found it perfectly safe and efficient.

Messrs. Bull and Coley, from a long experience of its use in radical cure of hernia, speak strongly of its superiority to silk. Prof. John Wood in his later operations (*i.e.* about 1880–85) employed kangaroo tendon to a large extent in place of

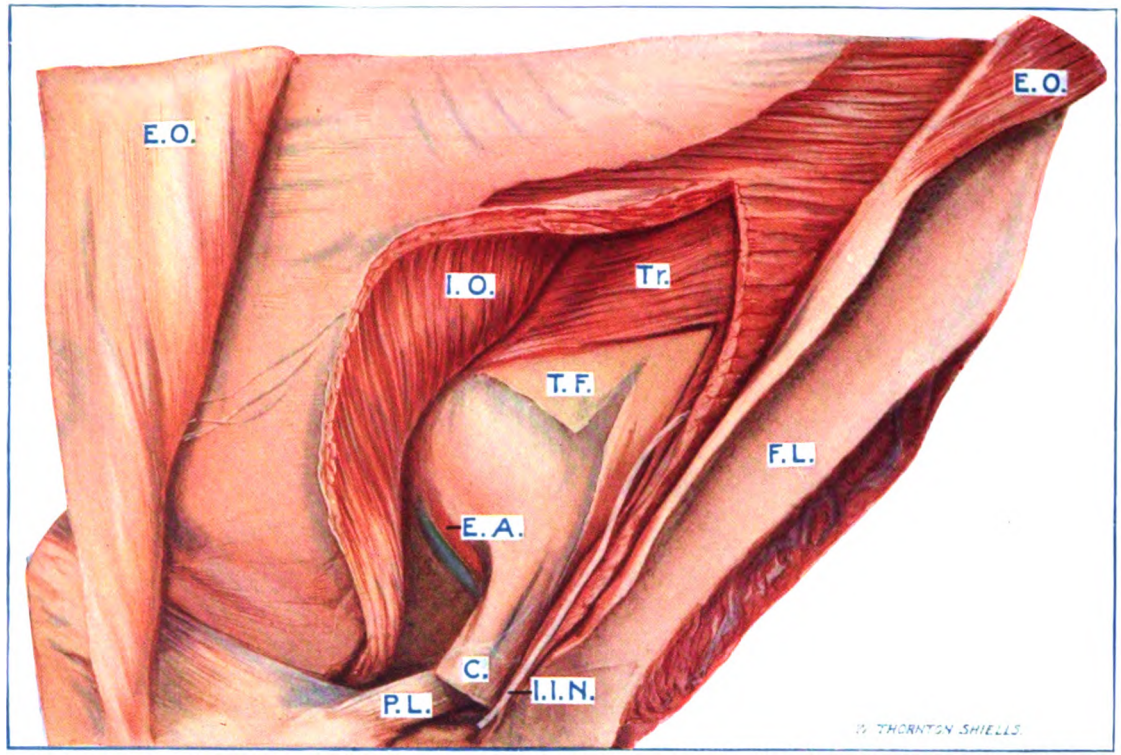
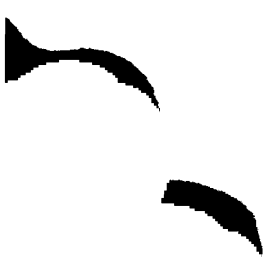


PLATE XII.—STRUCTURES CONCERNED IN THE RADICAL CURE OF INGUINAL HERNIA.

(From a Dissection in the Museum of the Royal College of Surgeons.)

E.O., EXTERNAL OBLIQUE APONEUROSIS DIVIDED AND REFLECTED ON EITHER SIDE. I.O., INTERNAL OBLIQUE MUSCLE PARTIALLY DIVIDED AND RAISED. Tr., TRANSVERSALIS MUSCLE. T.F., TRANSVERSALIS FASCIA PARTLY REFLECTED FROM THE INGUINAL HERNIA WHICH IT INVESTS. P.L., POUPART'S LIGAMENT. C., SPERMATIC CORD IN ITS FASCIAL SHEATH. E.A., EPIGASTRIC ARTERY. I.I.N., ILIO-INGUINAL NERVE. F.L., FASCIA LATA OF THIGH.



silver wire, which latter had to be removed some time after the operation.

During the last few years kangaroo tendon and silver wire have been re-discovered in America, and some surgeons there have gone to the extreme of burying quantities of silver wire not only in the muscles and aponeuroses attached to Poupart's ligament, but also in the subcutaneous tissues over it. A more unsuitable place than the fold of the groin for rigid wire knots it would be difficult to conceive. The large proportion of serious complications given in Bloodgood and Halsted's record (*Johns Hopkins Reports*, vol. vii., 1900) should deter any surgeon from following the method described. Thrombosis of the femoral vein, orchitis, and atrophy of the testicle were not unfrequently met with after radical cures of hernia which involved free division of the internal oblique, transplantation of the cord, excision of spermatic veins, and, above all, the insertion of many loops of silver wire into the deeper layers of the abdominal wall.

It is possible to secure a tough inguinal scar at too high a price if it involves thrombosis of the femoral vein and persistent œdema of the leg. Moreover, the formation of a tough scar is in no way essential to the permanence of a radical cure. In the most perfect cases the scar is hardly perceptible, and hence primary union of the whole of the wound should invariably be aimed at. Methods in which the wound is encouraged to granulate up in order that a large scar shall prevent recurrence are now completely discredited. There are no cases so difficult to operate upon as those in which a previous attempt at radical cure has been followed by suppuration; and it may be noted that in a considerable proportion of recurrent herniæ this complication has attended the original operation. Not only will the surgeon find recurrent herniæ especially difficult to operate on, but the prognosis becomes much more serious.

This is illustrated by the report of eleven such cases operated on at St. Thomas's Hospital in 1896. All the patients were under fifty years of age, and most of them were young men. In three cases slight suppuration was said to have occurred after

the original operation, but after the second it followed in no less than seven. Two of these patients died of septic peritonitis. It is possible that the use of silk or gold-beater's skin for the deep ligatures was in part responsible; and in one a ligature had been placed on the omental stump close to the colon ("which was possibly wounded"). Still, a proportion of suppuration in 70 per cent. and death in 20 per cent. after simple radical cure of inguinal hernia is unheard of in cases of primary operation.

It is thus obvious that rapid and sound healing of the wound is essential, and where the conditions are such that this is problematical the surgeon may well hesitate to operate.

Selection of Cases for Radical Cure.—In children with inguinal hernia of moderate size and easily kept up by use of a truss, operation may often be dispensed with. If, however, the truss is not well tolerated, or does not succeed in keeping the rupture up, there need be no great delay in resorting to operation. As a general rule it is best to wait until the child is two or three years old, but there are many exceptions.

In young adults the presence of a well-marked hernia, one reaching to or beyond the external ring, is a clear indication for radical cure. In such cases the use of a truss even for some years is rarely followed by obliteration of the peritoneal canal.

As regards operation after forty years of age each case must be decided on its merits, and to some extent by the patient's occupation. In some pursuits the wearing of a truss is almost impossible, in others it is only the slightest inconvenience. No age limit can be laid down, and we have had excellent results from operation for radical cure on patients over fifty years old.

In elderly subjects chronic bronchitis is the chief contra-indication to operation, since the lung symptoms will be increased by the anæsthetic, and may have a serious effect upon the healing of the wound. Very stout patients, and, still more, those with flabby pendulous abdominal walls, are unfavourable subjects. Spinal analgesia may be most useful in the operation.

Although the size of the hernia is no absolute criterion, a large irreducible one which has for long lodged much of the

intestine is not favourable for radical cure; still, even under these conditions the attempt may be justified by the result. In the case of a double inguinal hernia of reasonable size, both sides may well be operated on at the same time. The presence of several incomplete herniæ or weak spots in the abdominal wall should, however, be regarded as negativing the idea of operation.

Instruments Required.—Blunt hooks; scissors; scalpels; Wells' forceps; dissecting and fine-pointed forceps; curved needles; needle-holders, etc. Special mounted needles (of the pattern designed by Sir W. MacEwen and others) are sometimes used, but they are usually made too clumsy and blunt at the points. A simple long needle mounted on a holder and sharp-pointed is useful. It should be slightly curved on the flat. For introducing the deep stitches, ordinary fully-curved needles will be found more convenient than any special form. It is most important that all sutures, whether they are to be buried or not, should have been rendered perfectly aseptic. For the deep sutures there is nothing to equal kangaroo tendon which has been preserved in 1 in 20 alcoholic solution of carbolic acid, and which before the operation is placed in cold sterile water to remove the antiseptic agent. Those who do not employ kangaroo tendon will use silk or stout catgut for the buried sutures; of the two silk is probably the better, so long as it is not too thick.

The Incision, etc.—The whole of the pubic region having been shaved and carefully disinfected beforehand, the skin over the inguinal canal is finally cleansed with an alcoholic solution of carbolic acid or biniodide of mercury, and then dried with sterilised pads. The penis and scrotum, thighs, and upper part of abdomen are protected by sterilised towels. Only the region just above Poupart's ligament requires to be exposed, as the incision is placed here whether the hernia may have descended to the bottom of the scrotum or not.

The operator feels for the pubic spine, identifies the external ring and Poupart's ligament, and then proceeds to make a linear

incision which commences over the ring and runs for three or four inches parallel to and above the ligament (Fig. 96).

This incision goes straight down to the external oblique aponeurosis, which is the first landmark recognised; when it is exposed, the handle of the scalpel should be used to clear both the external ring and the aponeurosis upwards and downwards. In making this incision the superficial epigastric vessels and

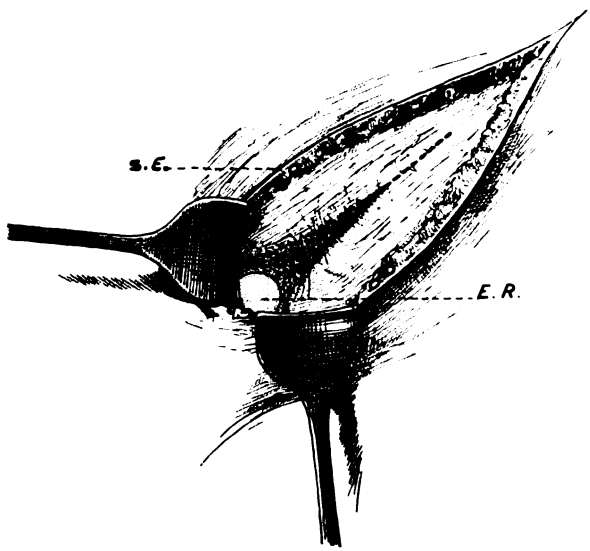


FIG. 96.—RADICAL CURE OF HERNIA.

Incision over the left inguinal canal, ending below at E.R., the external ring. The weak portion of the aponeurosis is stippled; the thick dotted line passes through this and indicates the cut made in the external oblique. S.E., Superficial epigastric vessels divided.

perhaps the superficial external pubic ones are divided, and should be at once secured with pressure forceps. These forceps should be held up by the assistant, as they serve as excellent retractors. Towards the end of the operation these small arteries and veins may be tied with catgut. In the great majority of cases the surgeon will incise the external oblique from one inguinal ring to the other, and we strongly advise the invariable adoption of this course. The incision is made through a very thin part of the aponeurosis (*see* thick dotted line in Fig. 96), and so far from

weakening the canal the subsequent method of suturing renders this part actually stronger.

The cut edges of the aponeurosis are held open, and the next landmark, the lower edge of the conjoined muscles, clearly defined. Just below this the cord, covered by cremaster muscle and fascia, is seen. It is well to work round this by blunt dissection from either side before proceeding further with the isolation of the sac. This will facilitate the subsequent placing of the deep sutures if Bassini's method is adopted.

The cremasteric covering is now peeled off the sac; this is done by blunt dissection with two pairs of forceps, and no part of the cremaster muscle need be actually divided.

The sac is almost invariably found in front of the main structures in the cord, and, if empty, is distinguished by its white colour and well-defined edge from the connective tissue, etc., which surrounds it. As a general rule the sac is empty; it is then unnecessary to open it. The left index finger raises the sac, whilst with fine forceps the spermatic vessel and the vas deferens are gently peeled off it, and held aside with the cremaster, etc., by means of a blunt hook. We will first consider the case of the sac containing omentum, etc., when it should be incised well below the internal ring.

Methods of Dealing with the Hernial Sac.—Two rules may be laid down: First, the contents of the sac must be wholly returned within the abdomen; second, the sac itself must be isolated right up to the internal ring. With regard to the contents, but little difficulty is usually met with in educing intestine. In some exceptional cases of hernia of the cæcum or sigmoid flexure it may be necessary to dissect off adhesions to the posterior wall; but any small intestine is readily returned and prevented from protruding during the further step by sponge pressure. Occasionally the bladder projects into the hernial sac on its inner side, and special caution should be exercised lest it be opened during the dissection—an accident which has happened in many cases. Whenever a thick, fat-covered elevation is found on the inner side of the sac, the nature of which is not easy to

determine, the surgeon should suspect a hernia of the bladder, and carefully refrain from cutting into it to demonstrate its nature. Torsion and displacement of the neck of the sac should be practised with due caution when a protrusion of the bladder is suspected. If by accident the latter be incised, the wound should be sewn up with Lembert's sutures and provision made for drainage of the wound. Retention of a catheter is not necessary. Several such cases have recovered without leakage or other complication. The bladder, after all, but rarely causes any difficulty in herniotomy, though Curtis and Gibson have collected records of 103 cases in which it was wounded during the operation, with a direct mortality of 12 per cent.

Much more frequently the omentum gives trouble, owing to its adhesions or to its local hypertrophy.* It is essential that the omentum should be freed completely, and the protruding part should as a rule be excised after securing its neck by several catgut ligatures. This should be done slowly and carefully, as in several instances death has followed the slipping of a ligature from the omental pedicle. On no account should the latter be used to plug the hernial orifice (as recommended by some writers), since it not only favours recurrence, but may cause trouble by dragging down the transverse colon and stomach, or even lead to fatal intestinal obstruction.

It is further important that the ligatures should not be placed too close to the large intestine, and that they should be thoroughly aseptic. Peritonitis has been known to result from the application of an infected ligature to the omental stump. The importance of dealing carefully and efficiently with the omentum is here emphasised because in this step of the operation want of care has led to one of the few complications of radical cure. The best and simplest method is to spread out the neck of the protruding

* In dealing with adherent omentum it is often best to disregard the lower adhesions, and commence with the pedicle, where adhesions will probably be absent. After ligature and division of this the omentum in the sac can be removed in one piece with the latter. This method is still more useful in umbilical hernia.

omentum, and to use fine silk, catgut or tendon on a blunt aneurysm needle. The latter is used to transfix the omentum at points free from vessels. The omentum is thus divided by loops of the ligature, which should *not* be interlocked, into two or more segments, each of which has a small bunch of arteries and veins in it. The reef knots should be tied tightly, and it is a good precaution to make each a treble knot. The omentum is now cut squarely across at a sufficient distance from the knots. The ends of the ligatures are held up and the operator makes certain that there is no chance of either of them slipping off, and that no vessel has escaped inclusion. The surgeon now cuts the ligatures short and gently pushes the omental stump within the abdomen. After its return it is a good precaution to introduce a small sponge on a holder through the internal ring to make sure that there is no hæmorrhage.

If the sac has not already been completely isolated from the cord this is now done; the higher up this is commenced the easier it is to effect. The spermatic vessels and the vas deferens are, as a rule, spread out around the sac, especially on its posterior aspect. In congenital herniæ they may project into its interior, covered by a fold of peritoneum. Their separation is mainly accomplished with forceps, which are used to peel off the vessels without actually taking hold of them. The left index finger introduced into the sac will facilitate the procedure. The separation is effected transversely to the neck of the sac. When once this is done, the constituents of the cord can be readily detached in an upward and downward direction.

If the hernia be of the congenital form the lower end of the sac is sewn up with fine catgut so as to complete the tunica vaginalis. In an adult, if the sac extends down into the scrotum it is usually best to follow it down to its termination and to isolate the whole of the sac up to the internal ring by blunt dissection, the position of the ring being recognised by the deep epigastric artery and vein. The sac is now grasped in a pair of Wells' forceps and held by the assistant. The procedure introduced by MacEwen of folding up the sac and making a pad, which is kept

in place by a deep suture, is rarely employed, and does not appear to have any special advantage. One of the following methods is to be adopted in preference :—

1. The sac is ligatured as high as possible with catgut or kangaroo tendon, which for security may be passed through its

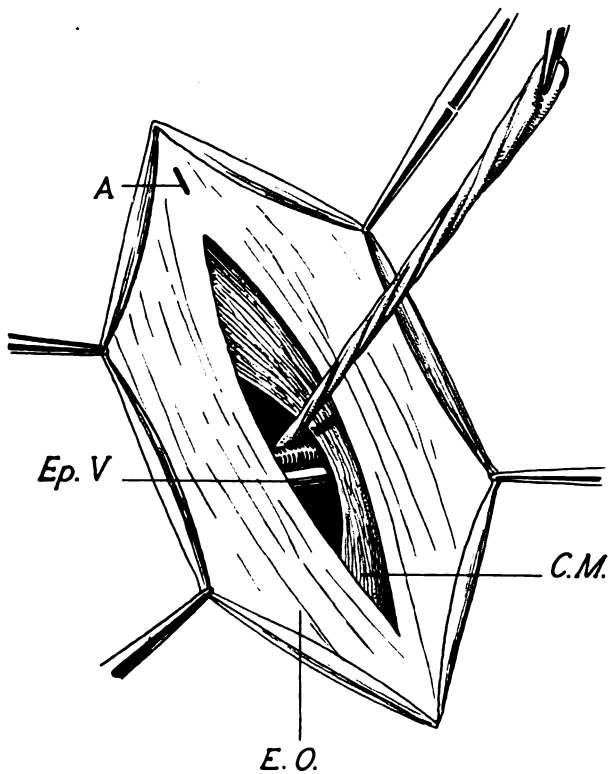


FIG. 97.—RADICAL CURE OF INGUINAL HERNIA.

Inguinal canal slit up. The sac is isolated and twisted, it is to be brought through the small opening A. E.O., External oblique ; Ep. V., Deep epigastric vessels ; C.M., Conjoined muscles. The spermatic cord is not shown for the sake of clearness.

neck and tied with the Staffordshire knot. The ends are cut short, and the stump left to itself.

2. The sac being ligatured in the manner described, each end of the ligature is successively threaded on a mounted needle with its eye close to the point. Guided by the left index finger

the needle is made to transfix the transversalis and oblique muscles at two adjacent points at least an inch above and to the outer side of the internal ring. The threads, being drawn through on the superficial aspect of the muscles, are now tied together so as to fix the stump away from the inguinal canal. It will be understood that the stump of peritoneum is not itself drawn through the abdominal wall, but simply anchored behind the latter well away from the site of its former protrusion.

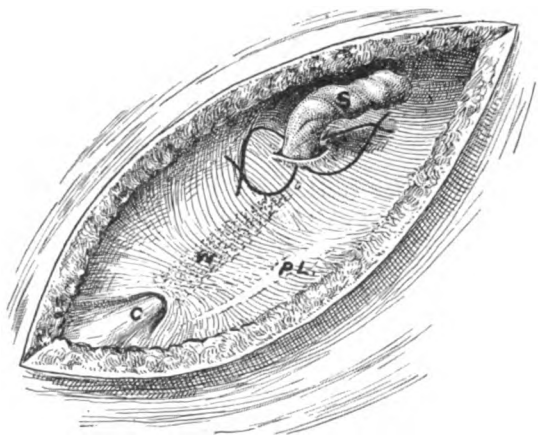


FIG. 98.—RADICAL CURE OF INGUINAL HERNIA.

P.L., Poupart's ligament; C, Spermatic cord. The stump of the sac (S) has been twisted and brought through a small opening made in the muscles, where it is fixed by two deep sutures which are shown not yet secured. The dotted area W indicates the thin portion of external oblique aponeurosis which is divided when the canal is opened up.

3. The sac is held by pressure forceps and twisted on its long axis several times. The left index finger is passed upwards along the canal under the oblique and transversalis muscles and a small incision made over its tip so as to allow a pair of forceps to be introduced from without inwards. The forceps are then opened and made to grasp the twisted sac, which is now drawn through the opening and securely fixed there by tendon stitches which maintain the torsion (Fig. 98). It will be understood that the opening is placed well to the outer side and above the internal ring, that it is completely plugged by the twisted sac, and that the superfluous portion of the latter is cut away.

Unless the sac be unusually thick, this method is a very good one, and no recurrence ever takes place at the site of the small incision. The advantage of torsion in tightening up the peritoneum in this region has been especially pointed out by Sir Charles Ball of Dublin and Prof. Kocher of Berne.

4. In a few cases where the abdominal opening of the hernia is exceptionally wide, it may be advisable to sew it up with catgut instead of ligaturing or twisting the sac. This applies to ventral as well as to ordinary inguinal herniæ.

It is doubtful which of the first three methods given above is really the best, though personally we incline to the second, which includes torsion with high ligation for most cases, the chief exception being those in which the sac is so thick that it would be difficult to bring it through any small incision in the muscles. In favour of torsion of the sac it may be urged that before the ligature is applied to its neck it renders its isolation easier, and keeps the sac empty. If the twisting is maintained by the deep sutures, in the manner described above, the peritoneum is tightened up around the site of the internal ring. Against torsion of the sac it has been alleged that now and then a piece of intestine or omentum within its neck has been twisted with serious and even fatal results. In any case it must be admitted that many surgeons never twist the sac and their results have proved to be excellent.

Methods of Narrowing or Obliterating the Inguinal Canal.—Three methods will be described :—

1. Suturing the conjoined muscles to Poupart's ligament behind the cord, with replacement of the latter in the inguinal canal (Bassini's method).
2. Suturing the conjoined muscles to Poupart's ligament in front of the cord.
3. Complete obliteration of the inguinal canal.

In young children and adults in whom the inguinal canal has not been stretched by the frequent descent of a hernia—in other words, those in whom the parts are normal but for the

presence of a congenital pouch of peritoneum—it is only necessary to deal with the sac in the manner described.

But in most cases where the radical cure is required, it is advisable that the canal should be narrowed, and considerable changes in the methods of doing this have been made during the last ten or fifteen years. Formerly narrowing sutures were placed in the external ring alone, or with the addition of one or more which drew the conjoined tendon over towards the external oblique in front of and above the cord. To place these stitches correctly without exposing the deep muscles by slitting up the external oblique is a difficult matter, and the external ring is not really at fault in the production of a hernia; it is, moreover, easy to narrow this opening too much with injurious effects upon the circulation through the cord. Of the three methods described, one includes the obliteration of the inguinal canal, the other two its narrowing at the upper end. It is both unnecessary and impossible to describe the host of modifications to which various surgeons' names have been attached.

1. *Suturing the Conjoined Muscles to Poupart's Ligament, with Replacement of the Cord in the Inguinal Canal.* — The aponeurosis of the external oblique has been divided parallel to and above Poupart's ligament from the external ring to a point just above the internal ring. The cord is thus exposed surrounded by the cremasteric fibres, and the lower edge of the internal oblique muscle is clearly defined as it arches over the cord. The latter is then lifted mainly by blunt dissection from its bed, and at the same time the inner surface of the external oblique is defined and cleared both upwards and downwards, so that the strong band which forms Poupart's ligament is thoroughly exposed. The cremasteric layer is then opened so that the sac can be isolated and dealt with by one of the methods already described. Any surrounding fat may well be removed, but unless a varicocele exists, it is unnecessary (as sometimes advised) to excise any of the veins of the cord. The cord is lifted up by two blunt hooks, which are held by an assistant, and a series of interrupted sutures of kangaroo tendon is passed through the

lower edge of the muscles that go to form the conjoined tendon, and through the inner edge of Poupart's ligament (Fig. 99). These sutures are introduced in a series before any one of them is tied. They all lie beneath the cord, and care must be taken in passing the curved needle through Poupart's ligament that the iliac vessels are not interfered with. By securing these sutures the internal ring is narrowed. The cord is now replaced and the two edges of the cut external oblique are sewn together again over the cord. The ilio-inguinal nerve must be avoided, or, if preferred, it may be resected. Finally, any subcutaneous vessels which have been held in pressure forceps are ligatured with fine catgut if necessary, and the wound is closed in the ordinary manner with silkworm-gut sutures without drainage. A sterilised dressing is applied with firm pressure, whilst the thigh is kept somewhat flexed. It is rarely necessary to remove the spica bandage until the tenth day, when the silkworm-gut sutures are removed and a pad and bandage reapplied. At the end of a fortnight to three weeks the patient may be allowed up. No truss should be worn.

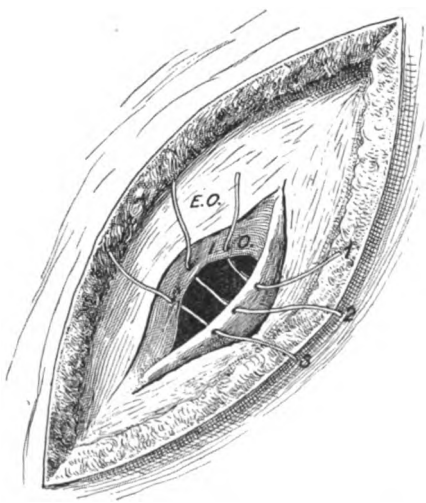


FIG. 99.—RADICAL CURE OF INGUINAL HERNIA.

The aponeurosis of the external oblique has been divided. Three deep sutures (1, 2, 3) have been passed through I.O., the internal oblique, the transversalis, and Poupart's ligament. E.O., External oblique. The spermatic cord has been purposely omitted in this figure for the sake of clearness.

The method just described is not applicable to all cases. In some the conjoined tendon is poorly developed, and in some it can only be fixed to Poupart's ligament with difficulty. This implies subsequent tension and strain when the patient uses his abdominal muscles.

2. *Suturing the Conjoined Muscles to Poupart's Ligament in front of the Cord.*—By the previously described method the surgeon narrows the upper opening of the inguinal canal to any desired degree, but it is not suitable for all cases, owing to the difficulties of bringing down the internal oblique and transversalis muscles to Poupart's ligament without undue tension. The method now to be described avoids this; it consists in "restoring the valvular action" of these muscles by giving them a lower attachment in front of the cord. It is, in fact, Sir William MacEwen's original operation performed after the canal has been laid open, and has therefore the advantage that the sutures are passed with greater ease and certainty.

It is assumed that the external oblique has been divided parallel to Poupart's ligament, that the lower edge of the conjoined muscles where they arch over the cord has been thoroughly exposed and isolated, and that the hernial sac has been dealt with in the manner described above. The lower portion of the external oblique, including the external pillar of the ring, is now held up with forceps, and a curved needle carrying a strong piece of kangaroo tendon (some surgeons use stout catgut, others silk) is passed from without inwards through the external oblique just above Poupart's ligament. The needle is then made to traverse the lower edge of the conjoined muscles from within—*i.e.* from their abdominal aspect—and back again, a quarter of an inch nearer the middle line. It is now passed through the external oblique the same distance from the original point of entrance. (Fig. 100.)

Thus the so-called mattress suture is completed; the needle is released, and the two ends of the suture are held in a pressure forceps until ready for tying. A second loop of suture is then introduced in the same way, and even a third may follow, all of them passing in front of the cord, which need not be raised from its normal position in the canal. Two points must be attended to—the ilio-inguinal nerve must not be included in any of the sutures (as it is very apt to be), and the suture material must be perfectly aseptic and not too thick.

The sutures are now tied and the lower edge of the muscles is thus brought down in front of the cord. It only remains to sew up the divided external oblique.

A modification of this method, especially suitable for inguinal hernia in women, consists in passing a series of interrupted tendon or silk sutures through the lower portion of the

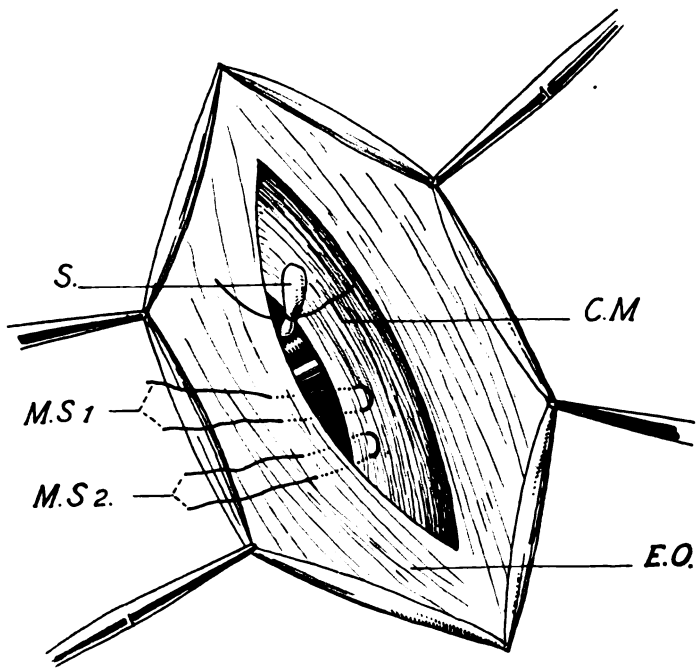


FIG. 100.—RADICAL CURE OF INGUINAL HERNIA.

The sac (s) has been isolated, tied at its neck, and cut off. The canal is to be narrowed by drawing outwards C.M., the conjoined muscles, by two mattress sutures, M.S. 1 and 2. E.O., External oblique. The spermatic cord is not shown for the sake of clearness.

external oblique, then through the conjoined muscles from within outwards, and finally through the upper part of the external oblique. These sutures should be placed very near to each other, and as the external ring is approached the external oblique only should be included.

It is presumed that aseptic healing occurs. In these circumstances the buried sutures may be relied on to last long

enough for all purposes, whether kangaroo tendon or silk has been used. It is often asserted that the tendon is quickly absorbed. In reply to this we would merely say that we have found it almost unaltered three and four years after it had been inserted. The small knots made in sewing up the external oblique with tendon can always be felt through the skin many months after the operation. In fact, the surgeon need be in no fear that by opening up the canal and subsequently suturing its walls he has weakened it at all, provided that aseptic healing be secured.

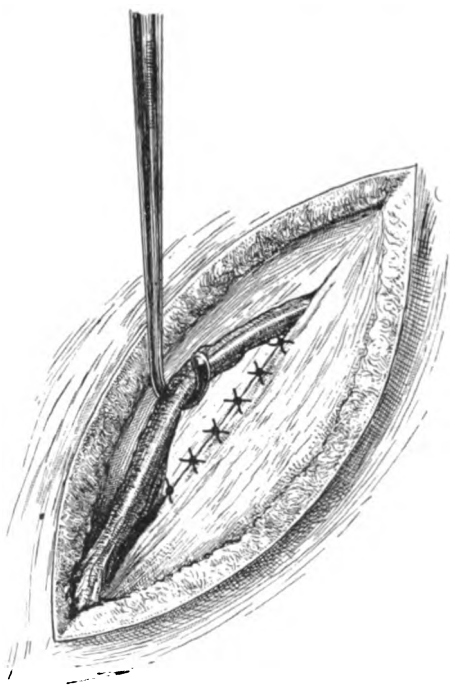


FIG. 101.—RADICAL CURE OF INGUINAL HERNIA. (*After Kelly.*)

Complete obliteration of inguinal canal by sutures. The spermatic cord is held forward on a hook.

3. *Complete Obliteration of the Inguinal Canal.*—The cord being freed from the internal ring down to the os pubis and the sac having been dealt with, the cord is held forward by blunt hooks, and a series of sutures is passed through the edges of the external oblique, the internal oblique, and the transversalis on the one side, and the lower part of the external oblique on the other side (Fig. 101). The lowest sutures will pass only through the former pillars of the ring. Room must be left at the upper end for the cord, which is now placed on the outer surface of the external oblique. If necessary, one or two stitches may be passed above the new aperture for the cord, but it is a mistake to make this unduly narrow, as the circulation of the testis will

be interfered with. There is no reason for the proposal to excise any of the spermatic veins unless there be a coincident varicocele.

The stitches should be placed close together, and whilst some advocate silk as the material, we strongly recommend kangaroo tendon. When the latter material is used and due care is taken as to asepsis, it is possible to perform a hundred successive operations for radical cure without the slightest trouble arising from a single stitch. The same can hardly be said if silk be used. Stout catgut is used by many surgeons, and it probably lasts a sufficient time in the tissues to attain its object. Chromic catgut is especially liable to work out, and should never be used for buried sutures.

A word of caution is necessary as to the deep epigastric vessels. In passing the uppermost sutures it has happened that the epigastric artery has been wounded and most serious hæmorrhage has ensued, even necessitating ligature of the external iliac artery. It should also be noted that the lowest suture is not placed close to the os pubis, as the pillars cannot here be approximated, nor is it necessary to attempt it.

In the female the round ligament may be disregarded and the canal obliterated completely.

When raising the cord in the male by blunt hooks in order to pass the sutures, it should be remembered that occasionally thrombosis of the spermatic veins has been produced—an accident which may also follow undue narrowing of the aperture made for the cord. Beyond the formation of a hard lump above the testicle and possibly œdema of the scrotum, little harm is likely to result, but in one or two cases symptoms of pulmonary embolism have been recorded. Hence the operator should be careful to avoid undue traction on the spermatic vessels during the operation, and also to allow sufficient room for their passage through the abdominal wall.

After the sutures have been tied and cut short, and the cord has been replaced over them, three or four fine catgut ligatures are usually required for the superficial vessels. The skin wound is then sewn up with silkworm gut.

In **congenital inguinal hernia** the sac is first isolated from the cord, and this is by far the most difficult part of the operation, since not only is the sac wall thin, but the spermatic vessels and the vas closely adhere to it, either projecting into or being spread out around it.

Nevertheless, by patient dissection with toothed forceps and fine probe, it is always possible to separate the sac from all the constituents of the cord at some point, and when once this has been effected it is easy to continue the separation upwards and downwards. In young children the vas deferens is a very slender structure, and may easily be divided if the knife be used during the separation of the sac. The latter process must be complete — *i.e.* no peritoneal covering must be left on the cord, otherwise recurrence of the hernia will probably take place. The isolated sac should now be divided transversely about an inch above the testicle. The lower part is formed into a tunica vaginalis. The upper is pulled down as far as possible, and dealt with exactly as the sac of an acquired hernia, additional precautions being necessary to clear the cord at the internal abdominal ring. It is freed of its connections, and placed as a pad on the abdominal aspect of the circumference of the internal ring, or, better, twisted up and securely fixed by tendon or catgut sutures in a small aperture made in the oblique muscles above and to the outer side of the internal ring.

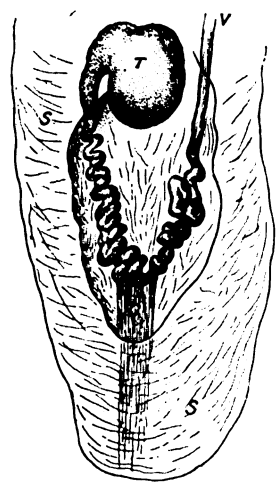


FIG. 102.—RETAINED TESTIS (T) WITH HERNIAL SAC (S) OPENED UP AND PARTIALLY DISSECTED AWAY IN ORDER TO SHOW THE LOOPING DOWN OF THE VAS DEFERENS (V) WHICH IS PRESENT IN SOME CASES.

G, A fibrous band connecting the loop of vas deferens to the scrotum — it represents the remains of the gubernaculum testis.

Hernia Complicated with Imperfect Descent of the Testis. —Even when the testis is retained in the inguinal canal it may be possible at the operation to draw it down into a pouch made for

it in the scrotum. All adhesions connected with the testis are to be freed, and one or two buried sutures are used to anchor the testis in place. As shown in Fig. 102, in these cases of partial descent, the vas deferens as a rule loops down some little way below the testis, and the difficulty of bringing down the latter rarely depends on shortness of the vas alone. In fact, if the other

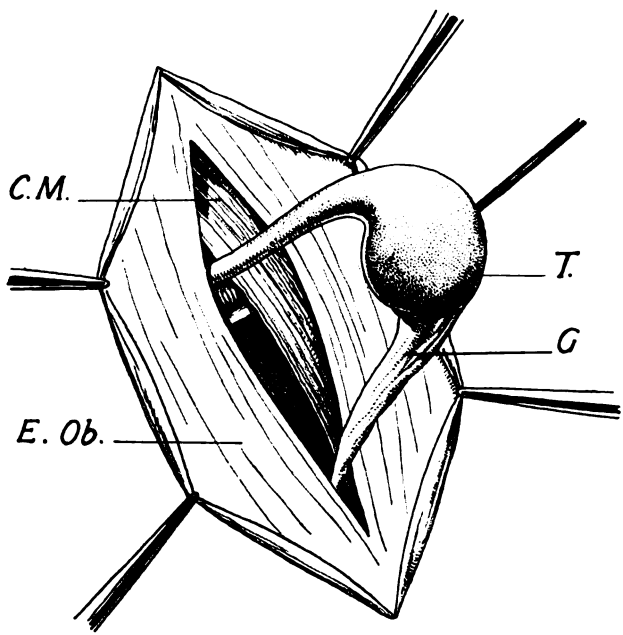


FIG. 103.—OPERATION FOR RIGHT INGUINAL HERNIA WITH RETAINED TESTIS.

Inguinal canal laid open above external ring. Testis enclosed in Processus Vaginalis isolated and drawn forward. E.Ob., External oblique aponeurosis; C.M., Conjoined muscles; T, Testis; G, Remains of Gubernaculum.

constituents of the cord, *i.e.* the spermatic artery and veins, are ligatured and completely divided across, the testis can usually be brought down without difficulty. There remain then the vas deferens, its artery, and one or two veins. The procedure is sometimes called Mignon's operation, and theoretically seems to be indicated whenever the testis cannot be brought down without it; as it corresponds to the operation for varicocele in the adult, there would appear to be no greater risk of atrophy

of the testis following one operation than the other. Servetti (*Gaz. Med. Ital.*, Sept. 20th, 1906) for example records four cases of Mignon's operation, in which the testes were apparently normal at the time the patient left the hospital. This, however, is not a real test, as it is necessary to follow up such cases for several months. I have myself known this procedure followed by the practical disappearance from atrophy of the testis six months after this operation. These partially descended testes are, it is well known, especially prone to atrophy, and it is therefore unwise to risk damage by cutting off their chief blood-supply.

When the testis can be drawn during the operation well below the pubic spine, it should be fixed there, the operator having cleared from above a pouch for it with his finger. The hernial sac is carefully isolated from the cord, and the radical cure completed by one of the methods described above. When the testis cannot be brought below the external ring, two alternatives are present. The first is to free the testis all round, and then to push it up within the abdomen, closing up the canal below it. This course has the disadvantage of adding to the contents of the abdomen one more imperfect or rudimentary organ which may give future trouble. We have known such a testis, returned within the abdomen, to undergo torsion and require removal. It is probably better in such cases to excise the testis, especially if the organ is obviously small and soft and the operation is performed in early adult life. If excision is done, special care should be taken to secure the spermatic vessels by a number of catgut ligatures.

To summarise: in cases of this complication of a hernia, if the testis is found already atrophic or wanting in development, and it cannot be brought well down, excision is the best course, as the radical cure is made certain thereby and nothing is lost of importance. If the testis be of fair size, and can be brought into the scrotum, it should be fixed there, although it is not likely to remain as low as is normal. If the shortness of the spermatic vessels alone hinders this step, complete division of the anterior bundle of vessels will overcome the difficulty, but there is

a real risk of such division leading to ultimate atrophy of the testis.

Dressing and After-treatment.—A drainage tube is never required. A light dressing of sterilised gauze is kept in place by a spica bandage, firmly applied when the thigh is slightly flexed at the hip-joint. A piece of mackintosh or other protective is secured over the whole in the case of young children, to avoid the chance of accidental contamination of the dressings from without. In infants or young children all dressing may be dispensed with, the wound being best dusted with boric powder. In adults the dressing is not disturbed for from ten to fourteen days, when the skin sutures are removed. As soon as the wound is soundly healed, the patient is allowed up, wearing a pad and bandage. At the end of three weeks he may get about as usual, but he should avoid any hard work for another three weeks.

Complications.—Retention of urine is not unfrequent for a few days after the operation, and may require the use of a catheter. Provided that no irritating material has been used for the deep sutures, there are hardly any other complications to be feared. If, however, thick silk has been employed, the surgeon must not be surprised at the occurrence of sinuses, which may persist for months until the sutures come away.

The anæsthetic is the chief risk, especially if the patient be stout and inclined to bronchitis. For this reason the operation is sometimes performed under local anæsthesia (the infiltration method or ordinary injections of 2 per cent. solution of eucaine). Mr. A. E. Barker and others have recorded successful operations of this kind, but it is probable that a general anæsthetic will continue to be employed in all but a small proportion of cases in which there is some special contra-indication to its use.

Spinal analgesia by means of intraspinal injections of stovaine has been employed in the radical cure of hernia with success by many operators during the last year or two.

Should a Truss be Worn after the Operation?—The answer to this question in the great majority of cases is certainly in the negative. As a rule the radical cure is thoroughly effective, no

recurrence takes place, and the main object of the operation would be lost if the patient were compelled to wear a truss. In certain exceptional cases—for example, a direct hernia in a subject with lax abdominal wall—a light truss may be advisable.

Ultimate Result of the Operation.—In what proportion of cases is a permanent success obtained from the operation for radical cure of inguinal hernia? In children and young adults recurrence should never take place, and is certainly very exceptional. In later life a small proportion, from 5 to 10 per cent., may be expected to relapse. The question should be studied under the following conditions. 1. The patients should be examined at least two years after the operation. 2. No truss should have been worn after its performance. 3. The cases should be in no way selected, the patients being taken from those whose ordinary work involves considerable physical exertion.

Under these conditions I (J. H.) followed up 100 cases of radical cure with the following result. In 5 per cent. undoubted recurrence *in situ* had taken place, in 3 per cent. there was doubtful recurrence. In 7 per cent. a fresh hernia had developed at another place to that operated on. This result agrees with statistics lately published by Carlé and Nicoladoni (6 per cent. of relapses *in situ*), and Ceccopieri and Scarrone (7 per cent.).*

The Operation in Cases of Strangulated Inguinal Hernia.—In almost every case the seat of strangulation is at the neck of the sac, *i.e.* about the internal inguinal ring. The incision should always be made over the whole length of the inguinal canal.

Although the necessary precautions to render the skin aseptic may be somewhat more hurried than in the case of a simple radical cure, they must be carried out as thoroughly as possible. It is well to wash out the stomach with warm water just previously to the operation. This may be conveniently done whilst the patient is under the anæsthetic.

The aponeurosis of the external oblique is readily defined

* *See* paper on "The Results of Operation for Radical Cure of Hernia," by J. Hutchinson, in *Lancet*, April 7th, 1906.

and divided over the canal, the cremasteric layer is next recognised and the sac opened with special care, as the bowel is probably just beneath it. Blood-stained fluid will often be met with in the sac, which should be picked up with fine-pointed forceps, and divided sufficiently to allow the entrance of one finger. It is now easy to lay the sac freely open on the finger by means of scissors or blunt-pointed bistoury. The sac is cleansed with sterile swabs, and its contents, omentum or intestine or both, inspected. The next step is to divide the stricture, the position of which is ascertained by the surgeon's finger, acting as a director. In incising the stricture the position of the deep epigastric vessels (to the inner side of the ring) should be borne in mind, and the cut made in the upward and inward direction. In the very rare cases of strangulated direct hernia the epigastric vessels lie to the outer side of the ring, but the same direction of the incision, upwards and inwards, will still apply.

The loop of bowel should now be gently drawn down and the constricted part examined, since it is here that the injurious effects of the strangulation may be most manifest.

The next step is to reduce the gut, the fibrous and muscular structures around the hernial orifice being relaxed as far as possible. In both inguinal and femoral ruptures this is effected by flexing the thigh upon the pelvis. An attempt is then made to squeeze the bowel by a kind of kneading movement with the thumb and fingers through the opening.

The manipulation must be of the gentlest, and the surgeon must be prepared to exercise considerable patience. If the coil will not return by pressure applied at one extremity, it may yield by pressure applied at the other end of the loop.

In some cases of difficulty, the reduction is rendered easier if the margin of the hernial orifice is held up by means of a small blunt hook introduced into it, or by two pressure forceps grasping the opened sac and straightening its neck. This especially applies to large inguinal herniæ.

In other cases more bowel may be drawn down from the abdomen, and the reduction may then be directed in the line

in which the withdrawal of the intestine appears to be the more easily effected.

If the bowel be much distended, that part nearest to the ring can often be emptied of some portion of its contents by judicious manipulation.

Any flakes of lymph that may be disturbed in handling the gut should be washed away with warm sterile water.

After the reduction the finger should be passed through the ring into the abdomen, to make sure that all is clear. The sac is now washed out.

If any omentum exists in the hernia, it must be dealt with as its condition demands. If it appears healthy, is small in amount, and is quite free from adhesions, it may be reduced. Nothing better can be done for it. In the majority of cases, however, it will need to be removed. It will be found to be altered in structure, to be inflamed, or to be matted into a granular kind of mass, or to be adherent.

Small portions may be ligatured *en masse* with one catgut ligature, and then cut off. Larger portions are most conveniently dealt with by passing a series of loops of catgut by means of an aneurysm needle, each loop enclosing one or more omental vessels. Fine catgut may be used, but each loop must be securely knotted, a treble knot being the safest. When the expanded portion of the omentum has been excised below the ligatures the latter should be inspected and cut short before returning the stump into the abdomen. The risk of a ligature slipping is avoided by making each include only a small part of the omental neck.

It is well to remember that, however large the protruded mass may be, it will have a comparatively slender neck.

The neck of the mass of omentum may be secured by a clamp, excised close to the clamp, and then treated by multiple ligatures. It is often possible to pick out the few individual vessels that exist in the mass, and to ligature them separately. The use of the clamp is, however, not so safe as the method of under-threading above described.

The reduction of the stump of the omentum should be in

every case complete. It should be returned quite free into the abdomen. No part should be left either in the sac or in its neck. All adhesions of the omentum to the neck of the sac must be cautiously and thoroughly divided, and the stump must be free. The employment of a stump of omentum as a plug to close the opening of a hernial sac is a procedure, as we have said before, which has nothing to recommend it. Fixed omentum is a fruitful source of intestinal obstruction, and omentum attached to a hernial orifice tends to perpetuate a rupture at the spot.

Treatment of the Sac and the Closure of the Wound.— In very severe cases, in which the patient is already much exhausted, and in which it is desirable to complete the operation with as little delay as possible, the sac may be left as it is, and the wound closed.

In cases of a less extreme degree, in which no complication exists that opposes the measure, the sac may be dealt with according to one of the methods of radical cure.

In the majority of cases the simpler the measure the better, and the methods described upon pages 342 and 343 will be found to answer the desired purpose of the operation.

The subjects of strangulated hernia are hardly in a condition suited to the performance of any elaborate or time-consuming operation; and for cases in which the rupture is exposed for the purpose of relieving strangulation, the more complex measures are ill adapted.

The wound having been well washed out, and any redundant skin removed, the margins of the incision are united by sutures. In inserting the stitches, the edges of the cut should be kept upon the stretch by means of two small blunt hooks. (*See* page 71, vol. i.) The best suture material is silkworm gut.

In the simplest cases, where the sac has been closed, and in those in which the sac has not been opened, no drainage tube is required.

In cases in which the parts have been exposed to much manipulation, and in those instances especially in which the sac is left open and *in situ*, or in which the gut is left in a precarious

condition, a drain should be employed. It may be removed at the end of twenty-four hours, or be retained longer, as circumstances direct.

After all hernia operations it is best to secure the dressings firmly by an elastic-webbing bandage outside the ordinary white linen or muslin one. A single length is applied in figure-of-eight and secured with a safety-pin. The amount of pressure required can thus be exactly obtained, the dressings cannot slip, and the strain in coughing or vomiting is taken off the wound (Fig. 31, p. 85).

Treatment of Complications.—A. *When the Intestine is Adherent to the Sac.*—Adhesions of the bowel to omentum are readily enough dealt with. The omentum, if it cannot be peeled off from the intestine, is cut away with scissors until only the slightest trace of it is left still attached to the gut, which can then be reduced.

Adhesions of the bowel to the sac may, when slight and recent, be broken down with the finger or a flat director; when, however, they are of old standing and extensive, their treatment becomes a matter of some difficulty. These examples of extensive and firm adhesions are for the most part met with in old umbilical or scrotal herniæ of large size, which have been for many years irreducible, and have perhaps been more than once inflamed.

The "breaking-down" of such adhesions must be a matter of infinite care, as the bowel is, as a rule, more readily torn than is the wall of the sac.

In any case in which long-adherent gut is reduced, it must be remembered that it is reduced with a raw surface, and that it will probably acquire a fresh attachment within the abdomen.

No loop of intestine should be returned the limbs of which are united by adhesions; and the same observation applies to reducible bowel which is adherent to reducible omentum.

B. *When the Gut is Gangrenous.*—Much has been written on the subject of the treatment of gangrenous intestine in hernia, and very remarkable differences of opinion have been expressed upon the question. It would be out of place here to enter into a discussion of this subject, or to consider minutely the physical

signs that may distinguish intestine which is gangrenous from that which may still recover.

If the bowel, when exposed, be in what may be termed a doubtful condition, it had better be reduced into the abdomen. It is in a more favourable position for recovery within the peritoneal cavity than within the inflamed sac. Before replacement, the parts concerned should be well washed with an antiseptic solution. Such a coil of bowel seldom travels far from the hernial ring. The sac should be left open, and a drainage tube of large size introduced. If the gut at a later period gives way, it will do so gradually; and as adhesions are rapidly formed, the intestinal contents will escape along the course of the open sac. Whatever theoretical objections there may be to this procedure, practice has shown that it may be safely carried out, assuming that it applies to bowel which is not actually gangrenous, but is in a condition which may be termed doubtful. It is remarkable to what an extent these loops of "doubtful" intestine recover.

If the bowel, when exposed, be found to be gangrenous, two courses are open to the operator:—

(1) The stricture may be divided, and the gangrenous bowel resected.

In carrying out the resection, either an artificial anus may be established, which can be closed by a subsequent operation, or the divided ends of the gut may be at once united and returned into the abdomen. The union may be effected by means of a double row of sutures, or by Murphy's button; by preference the former if the patient be in a condition to bear the lengthy operation. For discussion and description, *see* page 257 *et seqq.*

(2) The sac having been well opened up and well washed out with an antiseptic solution, the bowel is left *in situ* after having been incised. Means are taken to provide the most efficient drainage. Several surgeons of eminence advise that in these cases the stricture should be divided, and that the gut should be left *in situ*, having been first secured by means of two or three silk stitches passed through the serous and muscular coats, and then fastened to the skin. The objection to this plan is that the

abdominal cavity is opened up and exposed to infection from the putrid contents of the sac. A barrier of lymph will have already shut off the gangrenous segment, and this protective barrier is broken down. Should the bowel be in a doubtful condition, the plan last described may be advisable; but when it is actually gangrenous, it does not appear to have much to recommend it. It has been urged, also, that if the stricture be not divided, the intestinal obstruction is not relieved. This argument in favour of dividing the stricture is, however, not supported by experience. It will be found that when gangrene has set in, nearly all tension is taken off from the parts, especially when the gas and œdematous effusion which attend the process are evacuated by an incision; and it is usual for fæcal matter at once to escape when the putrid bowel is incised.

If there be no immediate escape of the intestinal contents, such discharge will take place as soon as the swelling of the parts has subsided, as a result of the incision of the gut.

As to which method is the better, the resection of the bowel or the leaving of the dead loop *in situ*, the decision must depend upon the precise circumstances of the case. A patient with so advanced and severe a form of strangulated hernia that the bowel has become gangrenous will hardly be in a condition to undergo a tedious and elaborate plastic operation. At the same time, conservative treatment of the gangrenous gut is very rarely followed by recovery. The subject, especially with regard to the safest method of performing enterectomy, is discussed in a paper by one of us (J. H.) in the *Clin. Soc. Trans.*, 1900, p. 71. In that paper details of 40 cases were given. In 11 of these the gut was left *in situ* or an artificial anus made. Every one of the patients died. In 14 cases resection was carried out by means of Murphy's button; only one patient recovered. In 15 cases circular enterorraphy after resection was performed; 7 patients recovered. It is thus plain that in dealing with gangrenous gut, resection with careful suturing offers the best chance, and that from 40 to 50 per cent. of the cases may recover. It is important that the resection should be carried out through healthy

intestine—*i.e.* wide of the gangrenous area, and it is better to remove too much than too little.

c. *When the Intestine is Wounded.*—The bowel may be accidentally wounded when too rash a division of the superficial parts is made, when adhesions exist between the gut and the sac, when the altered gut is mistaken for the sac, or when the loop of bowel comes into accidental contact with the edge of the hernia knife as it is being passed through the stricture.

The opening made should in each case be closed by means of Lembert's suture, the loop of gut should be returned into the abdomen, and if the wound has been extensive, it will be as well to leave the sac open, and to introduce a drainage tube, in case the intestine should give way at a later period.

After-treatment.—The importance of getting the stomach clear of foul regurgitated fluid in every case of strangulation has been alluded to. In bad cases, when the vomit before operation has been fæculent in odour and colour, the stomach should be washed out just after as well as before the operation. The repetition of this injunction is worth making because many cases of strangulated hernia have been lost owing to a sudden gush of fluid from the stomach getting into the trachea and swamping the lungs. The danger of this accident is an argument in favour of local or spinal analgesia in preference to a general anæsthetic.

But in any case of operation for strangulation of intestine, whether internal or external, we would urge that gastric lavage should be carried out at its close.

The usual measures are taken to prevent post-operative shock, including a warm saline and brandy injection *per rectum.*

Morphia should be avoided; if abdominal pain and restlessness are present, a ten-grain dose of aspirin may relieve these symptoms. It is well to rest the stomach and small intestine for two or three days, and with this aim feeding is carried on by the rectum. But cases vary much—and if the strangulated bowel was of good colour, if the vomiting has entirely ceased, and there is no distension, the patient may commence liquid food in very small quantities at the end of twenty-four hours.

There is not the least necessity for keeping the patient in one fixed supine position, and slight change from time to time will add to his comfort.

Retention of urine is not uncommon, requiring the use of a rubber catheter. There is a well-founded belief that in these cases as soon as the bowels have acted naturally all will go well. It is best not to give aperients, but if by the third or fourth day there has been no motion a castor oil or turpentine enema will probably succeed.

The worst complication is paralysis of intestine, due to peritonitis or to gangrene of the gut. This is to be feared if vomiting recurs after an interval, and the abdomen begins to distend, the pulse being abnormal (too quick or too hard). Turpentine enemata, hypodermic injections of strychnia and eserine (in 4-minim doses of the liquor of each) are worth trying. Aperients given by the mouth in such conditions are as a rule at once returned, and would be dangerous if they were not. In desperate cases the question of opening the abdomen and establishing a fæcal fistula may arise, but the chance of recovery after such a course is unfortunately very small.

It should not be forgotten that the contents of the sac of a strangulated hernia are always septic. In fact the fluid is usually a simple culture of the *Bacillus coli communis*. Hence whatever pains have been taken to render it aseptic during the operation, the tissues around may have become infected and primary healing may not occur. Sometimes it is only after a week or a fortnight that a rise in temperature and the patient's discomfort, etc., point to trouble. Whenever such symptoms occur the wound should be dressed without delay, and if necessary a stitch should be removed, and a probe or director gently passed into the wound. The suppuration is usually deep, and if exit for the pus is promptly afforded no harm will result. Of course a drainage tube should be kept in for a few days.

Proportion of Recoveries after Operation for Strangulation.—This depends almost entirely upon the severity of the strangulation and the length of time it has been allowed to exist. In

[illegible]

II.—THE RADICAL CURE OF FEMORAL HERNIA

The Incision.—The skin incision in this is not of much importance owing to the ease with which the skin in this region can be retracted. The centre of the wound should be placed over the upper part of the saphenous opening, but not below Poupart's ligament. Many surgeons make the incision vertical, extending a little outside above Poupart's ligament. Kocher places his incision along the inner third of this ligament. A curved incision with its convexity inwards and downwards seems to us the best, as the wound will then be placed as far from the genitals as possible, and will thus be well covered by the dressings (see Fig. 214).

The incision then begins over the external ring, nearly an inch above Poupart's ligament, and with a slight curve passes downwards and outwards over the saphenous opening for two or three inches. There is no layer of tissue with well-marked features, like the external oblique or the cremasteric layer in inguinal hernia, which the operator looks for. As soon as the superficial fascia is divided the sac is practically exposed. One or two adherent lymphatic glands may be found and may be later removed with the sac.

Isolation of and Opening the Sac.—The sac should be well isolated by a sweep of the finger before it is opened. Poupart's ligament and the superior cornu of the deep fascia are thus defined. The neck of the sac as a rule narrows remarkably as it passes beneath the cornu into the femoral ring. It is usually

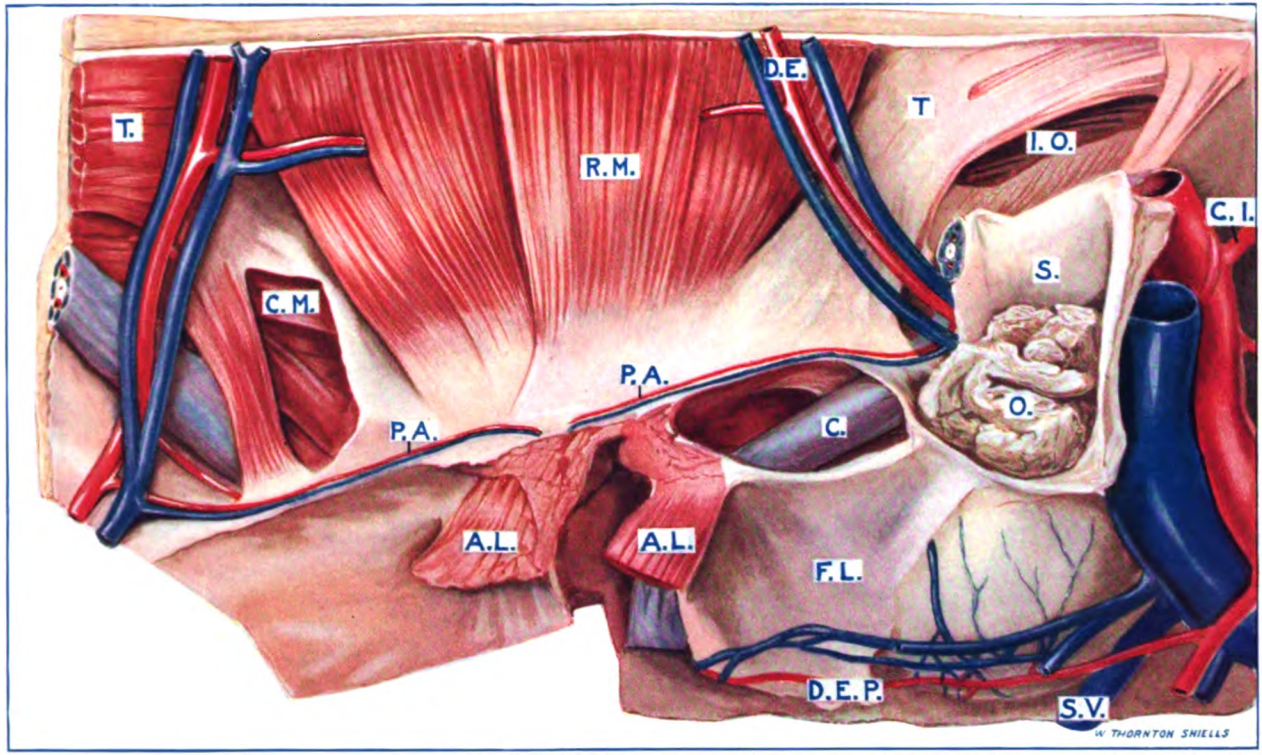


PLATE XIII.—STRUCTURES CONCERNED IN FEMORAL AND INGUINAL HERNIA, SEEN FROM BEHIND.

(*From a Dissection in the Museum of the Royal College of Surgeons.*)

ALL THE BONY PARTS HAVE BEEN REMOVED IN ORDER TO SHOW THE SPECIAL RELATIONS OF THE FEMORAL AND INGUINAL CANALS, ETC.

ON THE RIGHT SIDE A FEMORAL HERNIA CONTAINING OMENTUM (O.) IN THE SAC (S.) IS SEEN IN IMMEDIATE RELATION TO THE FEMORAL VEIN. BENEATH THE SAC AND FASCIA LATA OF THE THIGH (F.L.) RUN THE DEEP EXTERNAL PUDIC VESSELS (D.E.P.). S.V., SAPHENOUS VEIN. C., SPERMATIC CORD. A.L., ADDUCTOR LONGUS TENDON. D.E., DEEP EPIGASTRIC VESSELS. C.I., CIRCUMFLEX ILIAC ARTERY. P.A., PUBIC VESSELS. T., TRANSVERSALIS. I.O., INTERNAL OBLIQUE. R.M., RECTUS MUSCLE. ON THE LEFT SIDE—C.M., CONJOINED MUSCLES. T., TRANSVERSALIS.

cases where even the suspicion of strangulation exists the surgeon should lose not a moment in resorting to operation. The record of ten years' operations for strangulated inguinal hernia by one of us (Hutchinson, *Clin. Soc. Trans.*, 1900, p. 77) gave 83 per cent. of recoveries. Or taking a total of 551 cases operated on at four large hospitals by various surgeons, the number of recoveries was 437, that is 79 per cent. Hence we may safely put the mortality at about 20 per cent., but the operation in itself is practically free from risk, if performed with due care.

II.—THE RADICAL CURE OF FEMORAL HERNIA

The Incision.—The exact direction of this is not of much importance, owing to the ease with which the skin in this region can be retracted. The centre of the wound should be placed over the upper part of the saphenous opening, half an inch below Poupart's ligament. Many surgeons make the incision vertical, extending a short distance above Poupart's ligament. Kocher places his incision along the inner third of this ligament. A curved incision with its convexity inwards and downwards seems to us the best, as the wound will then be placed as far from the genitals as possible, and will thus be well covered by the dressings (*see* Fig. 104).

The incision then begins over the external ring, nearly an inch above Poupart's ligament, and with a slight curve passes downwards and outwards over the saphenous opening for two or three inches. There is no layer of tissue with well-marked features, like the external oblique or the cremasteric layer in inguinal hernia, which the operator looks for. As soon as the superficial fascia is divided the sac is practically exposed. One or two adherent lymphatic glands may be found and may be later removed with the sac.

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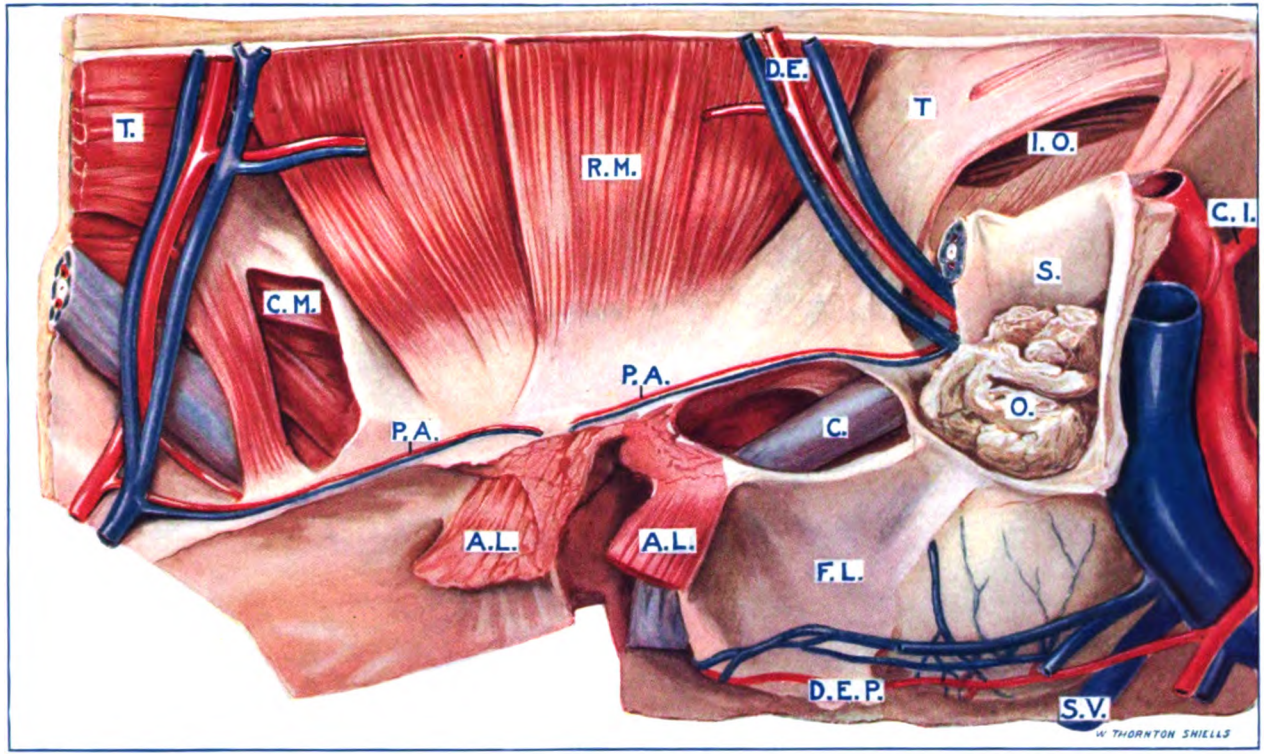

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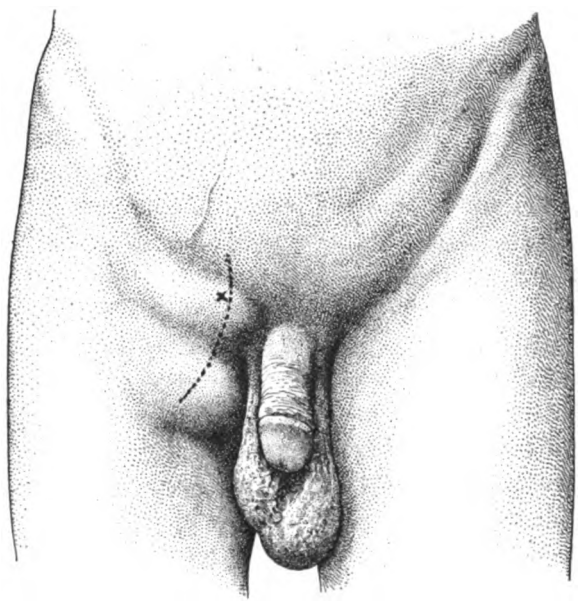
advisable to open the sac, unless the operator is quite certain by feeling the neck that it is empty. Should omentum be present it is dealt with in precisely the same manner as in operating for other forms of hernia (page 340).

In elderly subjects care must be taken of any projecting lump on the inner side of the neck which might prove to be a small pouch



TERZI.—

FIG. 104.—A LARGE FEMORAL HERNIA, THE UPPER PART CONTAINING OMENTUM, THE LOWER FLUID.

The curved line indicates the incision, the × marking the situation of the femoral ring.

of bladder. If this is suspected it should on no account be incised, but should be pushed within the abdomen and the neck of the sac secured below it. We have met with the bladder in several cases of radical cure, chiefly femoral. In one case one of us (J. H.) met with an inflamed diverticulum of the bladder in a femoral hernia, which was entirely destitute of peritoneal covering. The patient was an elderly woman.

with both ends sharply pointed, is passed through Poupart's ligament, as shown in Fig. 105. As before, care must be taken not to injure the femoral vein. The staple is hammered down into the pubic bone. It is difficult to drive the staple evenly into the bone, and to facilitate the process a special instrument has been devised by Professor Chiene.

The staple is intended to remain in permanently, fixing down Poupart's ligament close to the bone. It is obvious that it is easy to make the ligament press too much on the femoral vein, so causing thrombosis. Dr. Crawford Renton and others speak favourably of Roux's staple, which has been used some

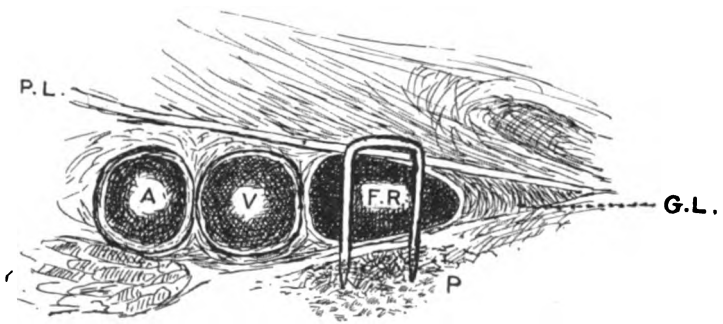


FIG. 105.—DIAGRAM SHOWING USE OF ROUX'S METAL STAPLE IN CLOSING THE FEMORAL RING (F.R.).

The staple is passed through Poupart's ligament (P.L.), and into the pubic bone (P). It must be hammered down further to close the ring. A, Femoral artery; V, Vein; G.L., Gimbernat's ligament.

hundreds of times by its originator. In how many cases it will work loose after a few years, possibly causing serious trouble within the femoral vein, only further experience can show. To use a steel staple in the average case of femoral hernia is unnecessary and inadvisable.

3. *Mr. W. H. Battle's Method.*—A full account of this is given in the *Medical Society's Transactions for* 1906, p. 343. From this the following extract, with Fig. 106, will make it clear. Silk is used for the deep sutures, and the essential point is the drawing down of a flap from the inner pillar of the inguinal ring and its suture to the pectineal fascia.

"A vertical incision is made over the sac and portion of abdominal wall adjoining it, directly over the line of the femoral canal. The sac is exposed, isolated, opened, and its contents, if any, reduced, adherent or diseased omentum being ligatured and any excess removed. After the sac has been emptied the neck is freed from the canal and ligatured with silk as high as possible. The body of the sac is then cut away, and the ligature kept long for a time. The upper part of the incision has exposed the aponeurosis of the external oblique, and by the use of a retractor the external abdominal ring

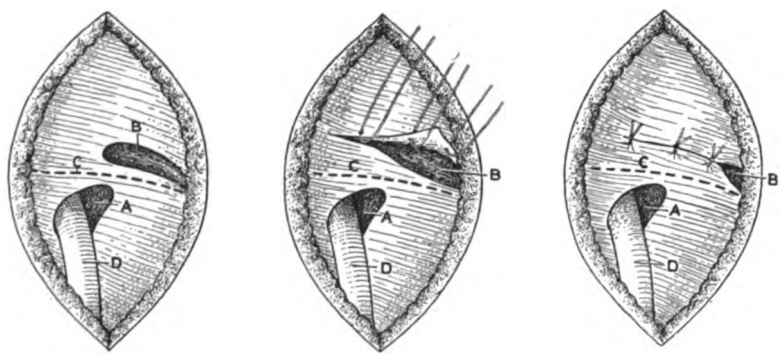


FIG. 106.—MR. BATTLE'S METHOD. (*After his drawings.*)

C (the dotted line) is Poupart's ligament; B, The external inguinal aperture; A, Saphenous opening; D, Saphenous vein. In the middle figure the internal pillar is raised by incision and three sutures inserted into it. By means of these the flap is drawn down behind Poupart's ligament and attached to the pectineal fascia. The third (right-hand figure) shows three other sutures which relieve tension on the flap. The figures are purely diagrammatic.

can be easily defined. Fatty tissue is cleared away from the surface of the aponeurosis and an incision is made outwards and upwards from the middle of the external ring, through the covering of the inguinal canal to a varying extent, according to the size of the patient, for about $1\frac{1}{2}$ inches. By this means two flaps are formed, an inner and an outer, and the object of the operation is to slide the inner behind the outer one and secure it over the opening of the femoral canal. The external pillar of the ring is now separated, with the portion of aponeurosis attached to it, from the contents of the inguinal canal, in such a manner that the part of Poupart's ligament which crosses the canal is well exposed to the view of the operator. If the part of the transversalis fascia above Poupart's ligament is thin, a

pair of artery forceps is passed through it from the femoral canal and opened, immediately above the ligament. If the fascia is better developed an incision is made close to and parallel with the ligament. Through the opening thus made the neck of the sac is drawn and the ligature cut off. There is thus no doubt that the canal is quite free of sac, the neck of which is now quite intra-abdominal. A silk suture is passed on a curved needle through the pectineal fascia and onwards through the femoral canal into the inguinal canal by way of the opening just made in the transversalis fascia. It is now passed through the edge of the inner flap of aponeurosis at the place which corresponds to the centre of the upper flap, and back again through the femoral canal. A second suture of the same material is passed to the inner side of the first from above through Gimbernat's ligament and the inner flap of the aponeurosis. A third is also placed to the outer side about $\frac{1}{2}$ inch from the central one and unites that part of the flap to Poupart's ligament. The outer and inner of these are then tied and afterwards the central one. The aponeurosis easily glides into its new position. As a rule only one suture is required to attach it to the pectineal fascia, but two may be advisable if the opening is large. By this means a shutter of great strength is placed below the ligatured neck and across the upper end of the femoral canal; it is moreover composed of living tissue, in no way separated from its normal vascular connections, and it will not atrophy.

"As it is obvious that this shutter, forming part of the abdominal wall as it does, would have a great strain thrown on its new attachments, should vomiting occur after the anæsthetic, or the patient be troubled by a cough, provision is made against this by suturing the free margin of the aponeurosis which is continuous with Poupart's ligament to the surface of the external oblique, in such a manner that the underneath portion (now the shutter) which closes the femoral canal is in a relaxed condition. By this simple device any pull on the parts is transferred directly to Poupart's ligament. The external wall of the inguinal canal is thus doubled in thickness throughout most of its extent, and the external ring is diminished in size. Sometimes a couple of sutures are placed externally between the pectineal fascia and Poupart's ligament, thus more strongly closing the femoral canal. Skin sutures are put in as usual, according to the fancy of the surgeon, and no drainage is required.

"Including cases mentioned in a paper published in the *Lancet*, of February, 1901, on this method of radical cure of femoral hernia, I have performed this method of operation 65 times."

Mr. R. H. Parry, of Glasgow, described at the meeting of the British Medical Association in 1901 (*see Brit. Med. Journ.*, October, 1901) a method which resembles that last described, except that the conjoined tendon instead of the internal pillar is sutured down to the pectineal fascia. The external inguinal ring is opened up for the exposure of the conjoined muscles, which are drawn down by loops of silk suture to the pectineal fascia, of course behind Poupart's ligament.

Both Mr. Parry and Mr. Battle claim good results from their respective methods.

Operation for Strangulated Femoral Hernia.—This operation, as regards its mortality (25 per cent.), stands midway between that of inguinal herniotomy (15 to 20 per cent.) and that for umbilical hernia (40 to 45 per cent.).

Preparation and Position of the Patient.—The skin over the area of the operation must be thoroughly cleansed and washed with an antiseptic solution.

When the region of the groin is concerned, the hair on the whole of the pubes and on the scrotum or Mons Veneris must be shaved away.

It is well that the bladder should be emptied. In long-standing cases, in which there has been fæcal vomiting, it is very desirable that the stomach should be emptied and washed out. This is the more necessary when the activity of the natural reflexes has been depressed by opium. In such cases the stomach may contain pints of fæculent fluid; and with this poisonous compound still in the viscus, the patient may be sent back to bed after the operation.

In the worst class of case the foul contents of the stomach gush forth by the mouth and nose as soon as anæsthesia is established, and death often follows thereon. The washing-out of the stomach may be accomplished either before or after the

operation, and when the patient is wholly or partially anæsthetised.

In the severest cases it is perhaps safest to do it before the herniotomy. Considerable relief follows this measure, and the shock is often distinctly modified by flushing the stomach with warm or hot water.

The best apparatus to employ is a syphon irrigator, and after the organ has been emptied some pints of water at a temperature of 100° F. can be passed through the stomach.

The patient's limbs and chest should be protected by blankets covered with mackintosh sheets. Every care must be taken to avoid exposure to cold, and it may even be well to have a few hot-water bottles in contact with the body during the operation in cases attended by much collapse.

Exposure and Opening of the Sac.—An incision is made over the neck of the sac, and as a rule in the long axis of the tumour. The fundus of the sac is frequently covered thickly with fat, and there may be a lymphatic gland on its convexity. In some cases the sac is thin and easily recognised, but in others the operator may have difficulty in defining it from the surrounding fat. Blood-stained fluid is often present in the sac, or deep purple intestine may be seen through it. The sac should be seized with fine-pointed forceps and opened with due care at its lower extremity.

Relief of the Strangulation if Present.—The opening in the sac is extended upwards towards the femoral ring, but not quite up to it; this latter precaution is to allow room for subsequent ligature of the neck. The two edges of the wound in the sac are seized with Wells' forceps and steadied by an assistant. The operator explores the interior with his finger. A common condition is for a small knuckle of intestine to be strangulated, whilst at the same time it is hidden by omentum. The latter should then be displaced outwards. The seat of strangulation is invariably at the femoral ring, and caused by Gimbernat's ligament and the deep curved arch of fascia. The operator seeks this point at the inner side of the neck of the sac, and insinuates the

tip of his little or index finger between the intestine and Gimbernat's ligament. If the ring is too tight to allow of this a hernia director is used instead of the finger. The assistant meanwhile is holding out of the way any omentum that may be present. On the grooved director or the palmar aspect of the finger the herniotome (Fig. 107) is slid against Gimbernat's ligament. As this is done care should be taken lest the intestine overlap finger or director and be wounded.

The sharp edge of the ligament is only too easily felt; it should be nicked with the knife at two points, no deep cut being made for fear of an abnormal artery. The advance of finger and herniotome is simultaneous. If the director (which is, of course,

FIG. 107.—COOPER'S HERNIA KNIFE.

neither so safe nor so accurate as the operator's finger) has been employed, the latter should be inserted after the first cut has been made to stretch the ring. Before returning the intestine within the abdomen it should be examined as to its viability, especially that part which has been in direct contact with Gimbernat's ligament. With regard to the condition of the gut, so long as it is resilient or elastic, and has not actually perforated, the surgeon should give it the benefit of the doubt, and return it "to join its fellows." A small line of ulceration or threatening perforation may be folded in and protected by Lembert's sutures. If definite gangrene of a loop of intestine be present the ideal treatment is primary resection with end-to-end union, though the patient's condition, age, etc., may not allow of it.

For consideration of this question and for the details as to dealing with other contents of the sac, *see* pages 357 and 361.

After the sac has been dealt with by high ligature and excision the radical cure is completed by Method 1 (*see* page 367). In exceptional cases where it is not deemed safe to close the femoral

ring, on account of the condition of the intestine, a drainage tube is inserted for a time. A radical cure may perhaps be done later if the patient wishes it. One rare complication of the operation for strangulated femoral hernia remains to be noticed, that of *serious hæmorrhage at the femoral ring.*

The operator may be reminded that the femoral vein lies to the outer side of the femoral ring, that the spermatic cord (in the male) lies just above its anterior border, and that the epigastric artery skirts its upper and outer part. The little pubic branch of this artery passes round the ring to ramify over Gimbernat's ligament. In one case out of three and a half the obturator artery arises from the epigastric. Out of 101 cases where the vessel so arose, it reached its destination in fifty-four instances by passing along the outer side of the crural ring, a position quite free from danger in herniotomy. In thirty-seven cases it passed backwards across the ring, and in ten instances around its inner border (Quain). The chance of meeting with this abnormal obturator artery in the dangerous position to the inner side of the neck of the sac is only about one in forty. Even then the risk of wounding it with the herniotome is slight if the following precaution be observed: Gimbernat's ligament should be notched slightly at two points rather than cut deeply in one; the finger is then insinuated beyond the ligament so as to ascertain whether the abnormal artery is present or not. In spite of the rarity of its abnormal course, this artery has been wounded in several cases during herniotomy, some of them fatal. The accident may not be noticed at first owing to the hæmorrhage occurring within the abdomen.

The bleeding may best be dealt with by enlarging the wound and ligaturing the bleeding point, or by making a special incision parallel to Poupart's ligament and exposing the vessel through it. The hæmorrhage has also been checked by the application of pressure, and in a less satisfactory manner by means of acupressure.

The subject of the wound of this artery has been fully dealt

with by Mr. Barker in a paper in the *Transactions of the Clinical Society* (vol. xi., page 180).

III.—RADICAL CURE OF UMBILICAL HERNIA

It is convenient to consider three forms of umbilical hernia, according to the age at which they are met with.

1. *Congenital Umbilical Hernia or Exomphalos.*—In this form the hernia is present at birth; it is usually of large size, as it depends upon a defect in union of the anterior abdominal parietes. The hernia, which commonly contains the cæcum and part of the large intestine as well as many coils of small intestine, is illustrated in Fig. 108. In most cases a true sac to the hernia hardly exists, there is merely a transparent membrane which adheres to and slightly conceals the coils of gut. The umbilical vein produces a thickening in the upper part of this membrane or sac, and requires to be carefully dealt with during the operation. The latter should be attempted in every case as soon as possible, since the infant cannot

FIG. 108.—CONGENITAL UMBILICAL HERNIA CONTAINING MUCH INTESTINE IN A THIN SAC.

The umbilical cord is shown, and the line of incision for radical cure.

survive unless the protruding contents are returned within the abdomen. It is surprising how easy it is to effect reduction and to close the aperture in the abdominal wall, neither a general nor a local anæsthetic being required. At the most a whiff or two of chloroform will keep the infant quiet. The false sac is of course entirely removed, the umbilical vein is ligatured flush with the abdominal wall, the intestines are gently cleansed and returned, the opening being rapidly sutured with silkworm gut. Success will depend on the operation being carried out at the earliest possible moment, *i.e.* within a few hours of birth, and on rapidity in operating. It is remarkable how well an extensive operation of this kind is tolerated; of three extreme cases of exomphalos operated on by one of us (J. H.) two were completely successful. Mr. A. E. Kennedy, of Plaistow, in one case of exomphalos found the lower part of the ileum congenitally imperforate. He excised this portion, joining the ileum to the cæcum by sutures, and returned the whole protrusion. The infant made an excellent recovery.

Of course, if operation has to be undertaken when the protruding coils of intestine have already become inflamed, recovery is almost hopeless.

2. *The Infantile Form of Umbilical Hernia.*—This, the common hernia in infants, appears some time after the separation of the umbilical cord, and is due to a yielding of the umbilical cicatrix. The rupture is generally small and simple. It exhibits a decided tendency towards spontaneous cure, is very efficiently treated by means of strapping so applied as to approximate the margins of the opening in the abdomen, and appears to have demanded operative interference of any kind very seldom indeed.

Instead of strapping, a form of abdominal belt, made largely of indiarubber with a small air-pad opposite the umbilicus, will be found effective in cases of some standing. Now and then an operation for radical cure is required; it will be of the simplest nature. The intestine, if present in the sac, is returned, the peritoneal orifice is sewn up by a continuous catgut suture, and in front of this the edges of the aponeurosis are sewn

closely together with kangaroo tendon (or if preferred with fine silk).

3. *The Hernia of Adults.*—This rupture may be quite small, and may contain but a single knuckle of bowel. When it becomes strangulated, the symptoms are apt to be acute, and to call for immediate treatment. The strangulation will usually be found to be at the lower part of the neck of the sac, *i.e.* to be brought about by the lower margin of the rigid hernial orifice.

In such case it may suffice to displace the hernia upwards, to make a vertical incision over the lower part of the tumour, to expose the sac, to open it or not as occasion suggests, and to divide the stricture by cutting from above (*i.e.* from the hernia) directly downwards. These ruptures are, however, exceptional, and the great majority of the umbilical herniæ that come under the surgeon's notice belong to the next category.

The hernia is large, and possibly of enormous size; the patients are most frequently women past middle life. They are usually corpulent, and often excessively so; their tissues are flabby; their muscular development is feeble; their digestive organs are deranged; and they are not unfrequently the subjects of embarrassed breathing. They make bad subjects for operation, and the unwieldy character of the huge and pendulous abdomen, which is shaken terribly by every cough, adds a difficulty to the after-treatment. The contents of these herniæ are usually in whole or in part irreducible. They generally contain omentum as well as bowel, and often present a loop of the transverse colon. Adhesions of an extensive and complex character may be anticipated, and the symptoms of strangulation are generally of a subacute character. The symptoms, indeed, are more allied to those that are associated with the so-called incarcerated or obstructed herniæ than to those of distinct strangulation. The coverings of the hernia are usually thinned, unhealthy, and discoloured; the mass is pendulous, and its general outline is lobulated.

If these herniæ are dealt with by operation, it is most desirable, whenever possible, that the "radical cure" should be carried out. To reduce the bowel, and leave the enormous sac behind,

is to place an obstacle in the way of safe healing, and to perpetuate the trouble.

Our results in dealing with these herniæ—which are not uncommon among the Jewish patients who apply at the London Hospital—have been infinitely better since we have in every instance not only reduced the protrusion but carried out the operation for radical cure which is here described.

The Operation.—In addition to the instruments already enumerated, the surgeon should be provided with ivory spatulæ, curved needles in handles, and large curved Hagedorn's needles.

The patient is prepared as for an abdominal section (page 93), and the general disposition of those concerned in the operation should be the same as is observed in that procedure (page 97). The surgeon will always stand to the patient's right.

The parts must be well cleansed, and, among the poorer class of patients, the need for such a preliminary is often unpleasantly evident.

After the whole hernial region has been well rubbed with soap and water, the skin should be repeatedly cleansed with an alcoholic solution of carbolic acid (1 in 20), or a similar solution of biniodide of mercury (1 in 500).

Nearly the whole of the skin involved in the protrusion is now marked off by means of an elliptical incision, the long axis of which will correspond to the median line. The incision will extend, indeed, on to the median line above and below the swelling; and as it crosses the tumour it will traverse its wall on either side, but a little way from its base. The incision is such as would be made to remove a pendulous tumour of like dimensions situated in the midst of comparatively lax tissues.

The first incision is only skin deep, and the hernia must be moved from one side to the other with the left hand as occasion requires.

The surgeon now deepens the wound upon one side of the base of the mass, and, by cutting through the subcutaneous tissue, aims at exposing the aponeurosis of the abdomen a little way beyond, *i.e.* to one side of the neck of the rupture. To

effect this, such skin as covers the base of the protrusion is turned back. When once the aponeurosis is reached, it is followed all round the stalk of the tumour by deepening the incision. When this has been done, the hernia, covered with perfectly undisturbed skin, will be entirely isolated from all the tissues outside the abdomen, and will be attached only by its neck. The neck must be well cleared, and the aponeurosis which bounds it, and which, therefore, forms the margin of the hernial orifice, must be laid quite bare.

The sac may now be opened at any convenient spot where it can be proved to be free from adhesion to its contents. The contents are exposed, and are dealt with in the manner already described. Adhesions are divided, the bowel is freed, and, if in sound condition, is reduced into the abdomen. Before this can be done, the hernial orifice will need to be divided; and this can be effected by enlarging the opening above and below the neck of the sac in the median line with a probe-pointed bistoury. This division may be extraperitoneal. After the gut has been replaced, the omentum is excised, or is dealt with in a manner suited to its condition (page 340).

The omentum is best ligatured and cut through where it emerges from the abdomen, without regard to its adhesions to the sac. By this method considerable time is saved in the operation.

The sac is at last emptied, and the hole leading into the abdomen is then plugged with a large Turkey sponge secured in a holder, or with a square gauze-pad.

The next step is to excise the whole of the sac and its coverings, including the elliptical portion of the skin, down to the level of the aponeurosis. This may be effected with the scalpel at one sweep.

The margins of the ring are now freshened, as in plastic operations involving the skin, and the opening in the aponeurotic part of the abdominal parietes is closed by sutures. These buried sutures should be of silk or of strong kangaroo tendon. They may be introduced on a curved needle in a needle-holder.

Before they are inserted, the sponge should be removed, and replaced by the end of an ivory spatula, which will serve to protect the intestines from injury. As many sutures as possible should be introduced before any are tied. They must be closely placed—four to six to the inch—and must include the whole thickness of the aponeurosis and the peritoneum.

In bringing together the thick edges of fat and skin care should be taken not to leave any "dead spaces" in which blood may collect. The sutures of silkworm gut must traverse the whole thickness of tissue from skin down to aponeurosis. Drainage may be unnecessary, but it is a wise precaution to leave a tube in the lower end of the wound for a few days. A dressing of sterilised gauze firmly applied by a binder and a few turns of broad elastic bandage completes the operation.

In the after-treatment it is important to help the patient's cardiac and respiratory functions by appropriate drugs (strychnia, digitalis, etc.), and by keeping her well propped up in bed. In fact a very stout patient must be kept in the sitting posture for the next few days after operation.

The mortality of strangulated umbilical hernia is much higher than that of similar operations for inguinal and femoral hernia. It is in fact not far short of 50 per cent. Hypostatic pneumonia and sudden cardiac failure are two frequent causes of death after the operation, and it is probable that the anæsthetic may be a contributory cause. If a general anæsthetic is given the amount should be as small as possible, chloroform or A.C.E. being the most suitable. In some cases the risk of the general anæsthetic cannot be run, and then a weak solution of β-eucaine should be injected around the neck of the sac. Intraspinal injections of stovaine or tropococaine might be tried. Of course the condition of the strangulated contents of the sac may be the cause of a fatal ending. Omentum which is deeply congested can readily be dealt with by drawing it out until a healthy pedicle is reached; this is divided after a series of catgut or fine silk ligatures has been applied.

It is not, however, the omentum but the intestine which affords the great danger. The transverse colon is often present,

and if strangulated, even for a few hours, will recover badly, and is peculiarly prone to become gangrenous. When the latter condition is present the surgeon's course is a most difficult one. Primary resection with end-to-end union is theoretically the best, but it will take considerable time. The establishment of an artificial anus by means of Paul's tube is in these cases rarely followed by success. Each case must be decided on separately, no general rule can be laid down, but of course if there seems a fair probability of the gut recovering it should be returned within the abdomen.

The heavy mortality of the operation for strangulated umbilical hernia points strongly to the advisability of performing a radical cure in every case before there is any question of strangulation. It has, however, been urged that the operation of radical cure is not satisfactory, a view with which we do not agree. We would urge that in almost every case of umbilical hernia in which a belt-truss is not satisfactory, in every irreducible case, the operation should be performed. Exception may be made of (1) a few cases in which the hernia is of enormous size, (2) those in which bad visceral conditions, *e.g.* cardiac or pulmonary disease, cirrhosis of the liver with ascites (this is not an absolute bar), or chronic nephritis, forbid any operation.

Some further points require to be noticed with regard to the **radical cure of umbilical hernia.** The structures which are available for closing an aperture at and about the umbilicus consist of the two layers of the rectus sheath. The muscles themselves are of little use, being usually thin and flabby. They afford no secure hold for any sutures.

Normally the two layers of the sheath unite in a firm "scar" at the middle line, and it is such a scar which the operator should aim to reproduce. In our opinion the best medium for obtaining this is strong kangaroo tendon, which becomes organised into fibrous tissue and will persist as such an indefinite time. If a single row is trusted to, the sutures should be inserted through both layers of the sheath (where they unite) as closely as it is possible to put them. Thus as many as twenty tendon sutures

may be applied to close an opening two or three inches in vertical diameter.

To relieve the tension a double row may be inserted as shown in Fig. 110.

The deep ones are mattress sutures which draw the aponeurosis on either side firmly together. The second row are closely applied interrupted sutures, also of tendon.

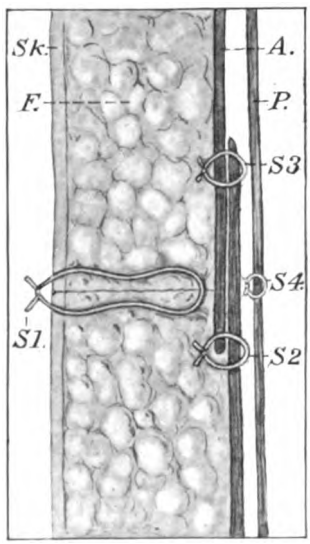


FIG. 109.—RADICAL CURE OF UMBILICAL OR VENTRAL HERNIA BY THE METHOD OF OVERLAPPING.

Sk. Skin; F, Subcutaneous fatty layer; A, Aponeurosis of rectus sheath; P, Peritoneum; S.1, Suture of silkworm gut closing skin and fatty layer; S.2 and S.3, Sutures (of tendon or silk) securing the two layers of aponeurosis; S.4, Suture of catgut closing the peritoneum.

Another method consists in the use of overlapping flaps of aponeurosis, consisting of the front layer of the rectus sheath. It will be understood from Fig. 109. According to Mayo (*Journ. Amer. Med. Association*, July 25th, 1903) the tension at the umbilical region is greater in the transverse than the vertical direction. Hence he advocates a transverse elliptical incision through the skin. The neck of the sac is exposed and cut through, and the contents dealt with in the manner described above. The peritoneum is sewn up with catgut. By means of two lateral incisions an upper and lower flap of aponeurosis are defined and separated from the edge of the recti. One flap is then drawn under the other by means of mattress sutures, and a second row fixes the edge of the overlapping one. Mayo's method has the warm support of Moynihan and Jacobson, and it seems to have been independently devised and advocated by more than one Continental surgeon.

Of course overlapping flaps of aponeurosis may be used in the vertical instead of the transverse direction. The argument

that tension is much less in the vertical direction seems to us to lack proof, especially as the long diameter of an umbilical opening is usually vertical.

One drawback to the overlapping method is obvious: the more the flaps are made to overlap the greater will be the strain upon the sutures.

An entirely different method consists in the insertion of a mechanical obstacle to the escape of the hernia. The apparatus employed is practically of two varieties, a thin perforated metal

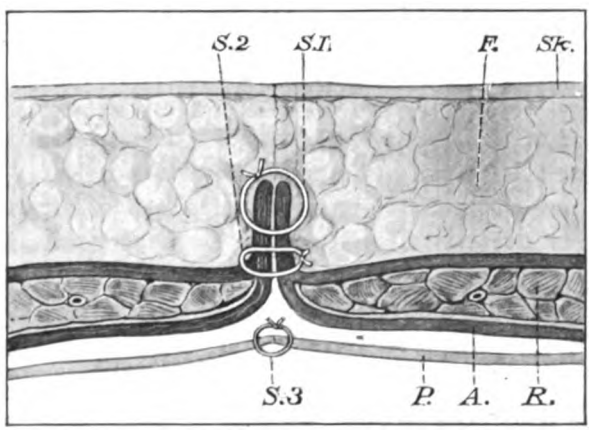


FIG. 110.—RADICAL CURE OF UMBILICAL HERNIA.

Sk, Skin; R, Rectus muscle; A, Aponeurotic sheath; P, Peritoneum; S.1 and S.2, Tendon sutures passed through rectus sheath; S.3, Catgut suture in peritoneum; F, Subcutaneous fatty layer.

plate or a silver wire filigree. Of the metal plates the best is that devised by Mr. C. A. Ballance; it is made of copper coated with platinum.

The plate should be somewhat larger than the aperture over which it is placed, and it should be secured in position by a few deep sutures at each angle of the plate. The opening in the peritoneum should first be sewn up; in the case of an umbilical hernia these sutures would include the posterior layer of aponeurosis with the peritoneum. Over the plate the superficial tissues are sutured as closely as it is possible.

The use of silver filigree or network has been especially advocated

by W. Bartlett, Phelps, and W. Meyer in America, by Witzel and Göpel on the Continent, by Douglas Drew and L. McGavin in this country.

Mr. McGavin gives a full and admirable account of the method, based on thirteen cases, in the *Brit. Med. Journ.*, Nov. 16th, 1907.

The chief points in this paper may be summarised thus :—

1. After the sac has been excised and the peritoneal orifice prepared, the recti muscles are separated on either side from their posterior sheath for some little distance by the surgeon's hand.

2. The posterior layer of aponeurosis and the peritoneum are sewn together by a continuous catgut suture so as to shut off the abdominal cavity.

3. The filigree, which has of course been previously sterilised, is placed just under the recti muscles. "Nothing now remains but to draw the muscles as far as possible together over the filigree, stitch the fat together in a very thick layer, and to close the wound."

There is no question that the use of silver filigree has given excellent results, and it seems to possess marked advantages over metal plates, which are more likely to shift and to act as foreign bodies. Mr. McGavin rightly lays stress upon the extreme importance of obtaining asepsis during the whole operation, though even the occurrence of some suppuration may not interfere with the filigree being retained.

It is easy for any surgeon to make the filigree for himself. All that is required is silver wire of No. 28 standard gauge, a wooden board and some nails or pins. It should be treated with ether to remove any grease, etc., and then sterilised by boiling in a solution of sodium carbonate in the ordinary way. It can be preserved in alcohol.

As with all methods of radical cure of hernia, several years must elapse before the perfect success of the filigree implantation can be tested. But certainly so far the method is most promising. At the same time, for the average case of ventral or umbilical hernia the use of stout kangaroo tendon sutures will enable the

operator to avoid the insertion of any such apparatus, which should be reserved for the extreme cases.

IV.—RADICAL CURE OF VENTRAL HERNIA

A ventral hernia may be the result of weakening of the scar of a former operation, *e.g.* ovariotomy or removal of the vermiform appendix; more commonly it is the relic of an intra-abdominal abscess. Sometimes in women who have borne many children the two recti muscles of the abdomen become widely separated, and the intestines tend to bulge forward between them. This special form of ventral hernia is rarely if ever suitable for operation, and the use of an abdominal belt will suffice for it.

In the case of a more defined and localised ventral hernia, at whatever point of the abdominal wall it is situated, an operation for radical cure should usually be performed. It is true that a belt with air-pad will usually prevent the hernia from giving much trouble, but it will never cure it.

Moreover, should strangulation occur in these ventral herniæ, the mortality is higher than in any other form.

The Operation.—The principles that control the operation are three: (1) to excise the weakened and stretched scar tissue in skin, fasciæ, muscles and peritoneum, so as to have fresh and normal tissues to bring together; (2) to separate or excise adherent omentum and to return any other contents of the sac within the abdomen; and (3) to suture closely and firmly each layer separately.

Thus if the ventral hernia be situated in the iliac fossa the surgeon by his first incision will enclose the whole scar by two curved incisions. The sac is then opened with care and detached all round; as a rule, it is extremely thin and adheres immediately to the scar. Adherent omentum should be ligatured with catgut and cut off; intestine, if adherent, is carefully separated and returned. The sac, being now emptied, should be dissected away from the edges of the gap in the muscles, flush with the general peritoneal lining.

As a rule, it is both difficult and tedious to make out the three

muscular layers separately, but the external oblique aponeurosis should at any rate be carefully detached from the two muscles beneath it; in these cases the transversalis and internal oblique are so closely blended that it may be almost impossible to separate them.

The edges of each layer, skin, oblique aponeurosis and muscles, are freshened and undermined so that they can be brought together with little or no tension. Meanwhile intestine has been prevented from protruding by a small sponge or flat gauze-pad, on a holder, introduced within the opening. Any superfluous part of the sac is excised, the ends of the incision are retracted by blunt hooks, the sponge removed, and the peritoneum sewn up completely with a continuous catgut suture. The pared muscle-edges are then sutured by kangaroo tendon of medium thickness, each interrupted suture being placed in close proximity to the next. The external oblique aponeurosis is sutured in the same way, and finally the skin sewn up with fine silkworm gut. All the scar tissue has been excised, so that the stitches are placed in healthy structures. The patient should be kept in bed for a full fortnight.

It will be seen that by this method no sutures require removal, except those in the skin, and these may be dispensed with by using a continuous catgut stitch or the skin metal clips.

Other Methods.—In order to obtain a firm scar when operating in the middle line of the abdomen the surgeon must be careful to take up in the grasp of his sutures not only the rectus muscle, but also the strong anterior layer of the sheath. Instead of relying wholly on buried sutures he may alternate these with silkworm-gut threads which include the skin as well as the recti muscles and sheath, and which are removed at the end of a fortnight. This is, of course, only a slight modification. A wholly different method consists in the use of some metal or rubber plate which is buried deeply in the wound after the peritoneum has been sewn up. Mr. C. A. Ballance recommends a perforated plate made of copper coated with platinum.

Mr. R. W. Murray has employed for large inguinal herniæ

a rubber pad with three apertures in it, a large one for the spermatic cord, and two smaller ones "to permit the soft tissues to grow into them and so assist in retaining the pad in position." (Murray, *Brit. Med. Journ.*, June 16th, 1906.)

Pads of celluloid and other material, besides copper, silver and rubber, have been tried. Whichever is used the pad should be shaped so as to overlap the opening, a few buried stitches should fix it to the overlying muscles or aponeurosis, and the latter should be sewn up as far as is practicable.

The method has been employed for umbilical, inguinal, and even femoral hernia as well as ventral.

The pad is intended to remain *in situ* permanently without acting as a foreign body. Unfortunately this rarely happens; the plate shifts in position, causes discomfort and local irritation, and as a rule it works out or has to be removed. Worse results, such as suppurative cellulitis of the abdominal wall, have occasionally followed the insertion of these appliances, the use of which can be avoided in nearly all cases by the employment of kangaroo tendon for the buried sutures.

Reference has already been made to the use of silver filigree, which is more promising than rubber or metal plates (*see* the section on Umbilical Hernia, page 384).

It is especially in elderly subjects with flabby abdominal muscles and a large ventral hernia that the filigree will find its best application. It is interesting to trace its development. Before 1880 the late Prof. John Wood and other surgeons employed strong silver wire in closing the apertures of umbilical and ventral hernia. But the wire used was too stout and almost always had to be removed after a time. Later many operators, *e.g.* Mr. A. E. Barker, used fine silver wire threaded on a needle, weaving it to and fro across the aperture, and thus strengthening the scar in the fibrous tissues. This is, however, a rather tedious and uncertain procedure, and the substitution of ready-made filigree is an improvement due to Bartlett and others. In one of McGavin's patients we understand that eight previous operations had been performed for the radical cure of a large ventral hernia!

After an operation for radical cure of a ventral or umbilical hernia, of course no form of truss need be worn, but we believe that a well-fitting elastic belt is advisable as soon as the patient gets about. It is easy to recommend careful dieting and exercise to diminish the stoutness of most of the patients, but very difficult to get the patient to follow out such directions. We have traced many successful cases of radical cure of our own of this kind for from two to eight years after the operation, and have found that as a rule the patients preferred after a time to discard any special abdominal belt in favour of their ordinary clothing.

The Question of Operation on very Large Herniæ.—We have urged the danger of strangulation in umbilical hernia (and it is as great if it occurs in ventral) as a strong argument in favour of operation for radical cure. But there are some huge herniæ which are best left alone. In the case of an elderly man sent to one of us (J. H.) by Dr. Miles Miley, an umbilical hernia hung down over the patient's thighs, and it evidently contained nearly all the hollow abdominal viscera. It caused little discomfort so long as constipation was avoided, and this fact has been noted in several such cases. The risk of strangulation is very small in these huge herniæ, whilst the difficulty of getting and keeping back the viscera in the abdomen by operation is very great. Mr. W. H. Battle records an instructive warning (*Clin. Soc. Trans.*, 1904, p. 246). A woman with a femoral hernia of enormous size, reaching to her knee, was operated on for radical cure. Its contents included much large and small intestine, the cæcum, etc., and the gall-bladder. To effect reduction it was necessary to divide Poupart's ligament. "The impression given when the operation was completed was that the diaphragm was compressed by the return of contents of the abdomen which had long been absent from their place. . . . Two days after operation the patient died with pulmonary symptoms."

Some writers speak of the question of operation on these very large and old-standing herniæ as though the only important point was the method of closing the opening through which they escape. It is not so, for the difficulty and risk chiefly depend

upon the contents of the hernia and their sudden return to a shrunken abdomen. Such a consideration, in a case where a bag-truss answers well, where the patient is elderly and perhaps bronchitic, and when the discomfort from the hernia is only slight, may well give the surgeon pause before he recommends an operation which may readily lead to a "surgical calamity."

V.—THE RARER VARIETIES OF HERNIA

Certain occasional inmates of a hernial sac are of such special interest as to deserve notice. Allusion has already been made

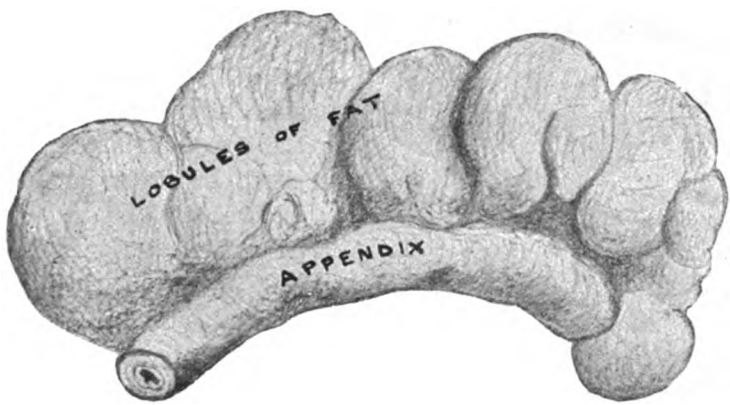


FIG. 111.—VERMIFORM APPENDIX, LADEN WITH FAT, WHICH WAS FOUND IN THE SAC OF AN OBSTRUCTED RIGHT INGUINAL HERNIA.

The appendix by its bulk acted as a ball-valve, preventing reduction of the intestine.

to vesical hernia (p. 339), and reference will now be made to (1) hernia of the cæcum and vermiform appendix, and (2) hernia of the ovary and Fallopian tube.

Hernia of the cæcum is fairly common in the right groin, and has been also met with many times in umbilical hernia and ventral hernia, as well as occasionally in a left inguinal sac. Its special interest from the operative point of view is the so-called "landslip of the cæcum," where this organ descends into the sac in part uncovered by peritoneum. The condition is rare, but we have met with it both in children and in adults. A similar absence of peritoneum on the posterior aspect is sometimes

seen in descent of the sigmoid flexure into a left inguinal hernia. In either case very careful dissection and detachment of the organ with scalpel and fingers is needed in order to return it within the abdomen. Radical cure is imperatively called for in all such cases.

Hernia of the Vermiform Process.—The peculiar features and possible complications of this form of hernia are fully dealt with in a paper in the *Brit. Med. Journ.*, Oct. 21st, 1899 (on the Vermiform Appendix in Relation to External Hernia, by J. Hutchinson). It is there pointed out how an attack of mild appendicitis may actually lead to the appendix becoming engaged in either inguinal or femoral canal. A swollen or fat-laden appendix has been found in an inguinal hernia acting as a ball-valve and preventing the return of intestine from the sac. In many other cases an inflamed and adherent appendix has been the sole inmate of a femoral or inguinal hernia, and its recognition has presented considerable difficulty (Figs. 111 and 112).

FIG. 112.—SAC OF FEMORAL HERNIA EXCISED WITH ITS SOLE CONTENTS—AN INFLAMED VERMIFORM APPENDIX, WHICH RESEMBLED A FALLOPIAN TUBE.

1, Root of appendix; 2, Adherent end; 3, Sac of hernia.

Treatment of the Appendix in a Hernia.—So long as there is no evidence of septic inflammation it is usually safe to return the appendix after separating any adhesions which exist, and some surgeons advocate this method even if the appendix is somewhat inflamed at the time. But provided that its root can be got at and a proper excision carried out (whenever possible by the "coat-sleeve method" with use of fine silk sutures), the best course is certainly the removal of the appendix. This view is

supported by the belief that the appendix first protrudes into the hernial sac when inflamed, and hence will probably remain liable to recurrent attacks.

The more serious cases where the appendix is acutely inflamed, or perhaps gangrenous, are much more difficult to deal with. If the appendix be left in the hernia a fæcal fistula may persist for long (over a year in a case recorded by Mr. Durham), whilst an operation undertaken to cure this fistula subsequently may prove fatal (case recorded by Hektoen).

Septic peritonitis may spread up from the sac if the sloughing appendix has been left, whilst the return of an acutely inflamed appendix has obvious dangers illustrated by several of the recorded cases. In one unpublished case a single ligature was put round the neck of the inflamed appendix, and the stump returned, with the result of fatal fæcal extravasation. The best course to adopt seems to be:

1. If the lower part of the appendix alone is inflamed and a healthy portion can be reached by traction, it should be excised as near the cæcum as possible, and with as much care in suturing as in a formal "appendectomy." It is of doubtful wisdom to fix the stump at the neck of the sac, since this prevents a proper radical cure of the hernia being performed. This course has, however, been frequently followed with success, and is certainly not open to the grave objections against plugging a hernial ring with omentum. The infected sac and any omentum which may happen to be present should, of course, be ligatured and excised.

2. If the appendix has become ulcerated high up at the neck of the sac (as has occurred in many cases), the danger of general peritonitis is increased, and it would seem to afford the best chance if a second incision be made above Poupart's ligament, through which removal of the appendix with disinfection and drainage may be facilitated.

3. When, owing to inflammatory adhesions, the operator has left an inflamed or perforated appendix within the hernial sac, as soon as the local condition has improved a formal excision of

the organ should be carried out and a constant source of danger thus removed.

Hernia of the Ovary and Fallopian Tube.—In some cases both these structures are found in a hernial sac, occasionally the Fallopian tube alone, much more frequently the ovary. They may be strangulated or inflamed, and the ovary itself may be cystic. Puech collected no fewer than 102 cases of hernia of the ovary; of these 88 were inguinal and 14 femoral. In a few rare instances the ovary has passed through the obturator foramen. Although met with at all ages, it is remarkable that many examples of hernia of the ovary have occurred in infants or young children.

In adults the herniated ovary is liable to periodical attacks of swelling and pain at each menstrual period. Every case of hernia of the ovary calls for operation and radical cure. Provided the organ is healthy, it should certainly be returned within the abdomen, but an inflamed, strangulated, or cystic ovary should be excised after careful ligature of its pedicle. The Fallopian tube should be dealt with in the same way.

Fatty Hernia.—In both the femoral and inguinal region, in the linea alba (especially above the umbilicus), and occasionally in other parts of the abdomen, protrusions of the subperitoneal fat are sometimes met with. They are readily mistaken for true omental herniæ, and in a considerable proportion a pouch or tube of peritoneum is drawn into the centre of the fatty mass; subsequently omentum or intestine may protrude into the pouch. The true fatty herniæ, especially when situated in the upper part of the linea alba, are apt to cause curious nervous symptoms—attacks of radiating pain, nausea, etc. Whenever present they are quite unsuitable for truss pressure, which only increases the patient's discomfort, and it is usually worth while to operate on them. The fatty tumour is exposed and readily isolated back to the point where its narrow pedicle comes through the aponeurosis; the opening in the latter, being enlarged, is thus converted into a linear one.

Search should be made for a peritoneal pouch in the centre

of the pedicle—and if a tag of omentum has worked into this it should be ligatured separately.

After ligaturing the neck of the lipoma it is returned within the aponeurosis, and the opening in the latter thoroughly sewn up with kangaroo tendon.

It would be incorrect to assert that when the fatty hernia has been removed the nervous symptoms associated with it disappear in every case. But experience has shown that this good result occurs in the majority, and seeing that for this form of hernia a belt or truss is useless, the operation should be advised. A warning note may be given as to the extreme importance of asepsis, as we have heard of one case in which excision of a small fatty hernia (in the centre of which was a peritoneal pouch) was followed by fatal peritonitis.

Fatty herniæ in either the femoral or inguinal region should be operated on if they cause definite symptoms. Their relative frequency may be inferred from a paper on Lipomata in Hernial Regions, by J. Hutchinson (*Path. Soc. Trans.*, 1886). Twenty-five instances were found in the inguinal canal and scrotum, five only at the site of femoral hernia. They are decidedly more frequent on the left side than the right.

Obturator Hernia.—In this form the gut escapes through the obturator canal, between the horizontal ramus of the os pubis and the uppermost fibres of the obturator externus muscle. The obturator vessels may be found either on the outer or inner side of the sac, or above or behind it. Among the cases collected by Dr. Charles Firth (*Brit. Med. Journ.*, April 19th, 1890) the vessels were to the inner side in six cases, to the outer side in six cases, and behind the sac in three cases. The proximity of the nerve renders it very liable to be pressed upon, and pain along the nerve is often a marked symptom of the rupture.

The hernia presents beneath the pectineus muscle, to the inner side of the capsule of the hip, behind and to the inner side of the femoral vessels, and to the outer side of the adductor longus tendon. This hernia is more common in females, and it

is worthy of note that the obturator canal can be examined to some extent through the vagina.

The *operation* for exposing the hernia *in situ*, when strangulated, is carried out as follows:—

The pelvis of the patient should be well raised on a sand-bag.

The parts having been duly cleansed, a vertical incision, from three to four inches in length, is made over the tumour, midway between the line of the femoral artery and the spine of the pubes. The subcutaneous tissues and fascia lata having been divided, the upper edge of the adductor longus muscle is reached. The deep external pudic artery would probably be severed. The upper border of the long adductor is pulled downwards and inwards with a wound retractor.

The fibres of the pectineus muscle are either separated by using the handle of the scalpel, or are divided transversely.

The obturator muscle is next defined, and the sac exposed by a little careful dissection. The hernia may protrude above that muscle or through its uppermost fibres.

The thyroid membrane is then nicked in a downward direction, and the gut reduced. The sac may or may not be opened. Care must be taken not to wound the femoral or saphenous veins. In dividing the constriction, a lateral incision should be avoided. The sac may be dissected out, and its neck ligatured, as was done in Dr. Firth's case. Before the wound is closed, a drainage tube should be inserted.

Dr. Firth states (*loc. cit.*) that out of twenty-five cases recognised during life, seventeen were subjected to operation, eight were relieved by taxis, but only five altogether were saved by the two methods of treatment.

The chief reason for this high mortality seems to have been the condition of the intestine at the time of operation. If the loop of small intestine is obviously gangrenous it is useless to return it, and the best hope seems to us to lie in making a median abdominal section, in drawing out the damaged loop and performing resection by means of circular enterorraphy.

The bowel may be reduced through an incision made in the

median line of the abdomen, traction being made upon the gut while pressure is brought to bear upon the tumour in the thigh. This method would appear to possess distinct advantages if carried out in suitable cases and at an early period. The operation has been performed by Mr. Hilton and by Mr. Godlee. In both cases, however, death resulted.

A full account of the various forms of obturator hernia is given by M. Paul Berger in Duplay and Réclus' "Traité de Chirurgie," vol. vi., pp. 811–24. M. Berger in this article expressed contempt for the idea of operating upon a strangulated obturator hernia from above, *i.e.* through an abdominal incision. It is true that this route has been hitherto taken, as a rule, by mistake. The hernia, being small, has been overlooked, and the case treated as one of acute intestinal obstruction. Moreover the results have not been good, though perhaps not worse than those following other methods. But it seems to us that in future if obturator hernia is diagnosed or suspected the best course to adopt will be the following:

1. The patient, being anæsthetised, is placed in the Trendelenburg position, and a median laparotomy performed (with caution as to the bladder being first emptied). If there is no doubt as to the existence of the hernia on one side, an incision through the outer border of the rectus muscle will be more convenient, but the median incision allows better for examination of both sides.

2. Both obturator and femoral rings are thoroughly examined with the aid of an electric head-lamp. If a hernia is found the ring can probably be stretched by means of a blunt, flat director, sufficiently to allow the intestine to be drawn back. If not, the *lower* edge of the obturator ring is incised with a herniotome. The strangulated loop is dealt with according to its condition.

The sac could probably be drawn inwards and removed; if not its neck could be closed by sutures, and the sac drained if necessary in the thigh.

We have not had personal experience of this intra-abdominal method, but found it most satisfactory in a case of paravesical hernia in which the sac was quite as deeply placed as the obturator

foramen, and was indeed close to it. After liberation of the strangulated knuckle it was easy to complete a radical cure by suturing together the edges of the opening.

Other Rare Forms of Hernia.—A few words of reference must suffice for these, as the chance of operating upon any of them is quite exceptional.

Lumbar Hernia.—Mr. Macready (*Lancet*, Nov. 8th, 1890) has collected twenty-five examples of this hernia. In six, strangulation occurred; of these, two were operated upon: one recovered and one died. One case appeared to have been untreated, and the remaining three were successfully dealt with by taxis.

The radical cure of a lumbar hernia offers no particular difficulty. After ligature and return of the neck of the sac the opening in the muscles should be thoroughly closed by buried tendon sutures.

The first operation of this kind was performed by Mr. Edmund Owen (*Brit. Med. Journ.*, May 5th, 1888).

Sciatic Hernia.—M. Wassilieff (*Revue de Chirurgie*, March, 1891) describes a case in which strangulation occurred. The rupture was successfully reduced. He enters fully into the anatomical relations of this uncommon hernia, and the operation which should be carried out, should such treatment be demanded.

Perineal Hernia.—M. Winckel (*Annales de Gynécologie*, August, 1890) deals very fully with the subject of this hernia, with its varieties and anatomical relations. He advises the treatment of this form of rupture by a radical operation.

Intraparietal and Prevesical Hernia.—Two papers on these exceptional forms of hernia, with references to the literature of the subject, are given in the *Med.-Chir. Soc. Trans.*, 1899, p. 305, by G. H. Makins and J. Hutchinson, Jun. Each writer records a successful operation for prevesical hernia.

CHAPTER XIII

OPERATIONS ON THE VERMIFORM APPENDIX AND ON APPENDIX ABSCESS, ETC.

ONE hesitates before plunging into the oceans of literature that exist on this subject. On no other surgical topic has more dogmatism been wasted or have more statistics been misused. As Mr. F. T. Paul (*Brit. Med. Journ.*, Oct. 26th, 1907) well says, "For years we had the cry of 'Operate on diagnosis' in appendicitis—a most pernicious doctrine, now happily losing ground."

A more dangerous doctrine still was loudly proclaimed, and is still occasionally heard, that whenever a pericæcal abscess is opened the appendix *must* be removed at the same time.

One writer on the subject has a special incision for reaching the appendix, another a special method and a special clamp for removing it; all other incisions and methods are banned! But these eccentricities are of little moment, whilst some of the controversies concern difficult and important points. It should not be forgotten that dogmatic rules as to the time and scope of the operation for appendicitis will always have exceptions, since individual cases differ so much in their severity and their progress.

The rules that follow are therefore to be taken merely as rough deductions from a personal experience of many hundreds of cases, as, moreover, agreeing in the main with the views of the moderate school of operators. Mr. W. H. A. Jacobson ("Operations of Surgery," edition 1907, vol. ii., pp. 287–314, and the *Polyclinic*, December, 1900) admirably discusses the points at issue between the two main camps of operators: those who operate practically on every case of appendicitis when they are first called to see it, and those who select the time for

operation according to the local and general symptoms. To Mr. Jacobson's articles and to the books on the subject of Appendicitis by Sir F. Treves, Messrs. C. B. Lockwood, Battle and Corner, A. H. Tubby, G. R. Turner, Howard Kelly of Baltimore, Dr. Mynter of Niagara, Dr. Morris of New York, and others, the reader may be referred.

In the operative treatment of appendix inflammation comes, of course, first and foremost, the immediate saving of the patient's life. Hence prompt operation is required on every case of fulminating appendicitis, usually attended with gangrene of the organ. The presence of grave complications, such as advanced pregnancy, must not be a reason for hesitation in such cases; immediate operation and free drainage afford the only hope.

One of us (J. H.) operated on a young woman in the eighth month of pregnancy, with gangrenous appendicitis. The sloughing appendix lay high up close to the uterine fundus. There were no adhesions, but abundance of very foul fluid all round the cæcum. The appendix was ligatured at its cæcal attachment and excised, the fluid was sponged away, and the lower peritoneal cavity was washed out and cleansed as far as possible. Two large drainage tubes were inserted into Douglas's pouch and the right iliac fossa. The patient made an excellent recovery, and some weeks later bore a living child. No ventral hernia developed.

The patient's temperature is not a good indication in these fulminating attacks; it may, indeed, be abnormally low. Intense local pain and tenderness, with perhaps rigidity of the right lower abdominal muscles, rapid pulse, repeated vomiting, thoracic respiration, flushing, and anxious expression of the face—such are the most trustworthy signs. Rectal examination may reveal free fluid in Douglas's pouch, a blood-count *may* indicate leucocytosis. But it is the rapidity of onset and severity of the symptoms that will lead the experienced surgeon to decide that not a moment is to be lost in operating. In such cases ether, and not chloroform, should invariably be chosen if a general anæsthetic is employed. It will be understood that in these

fulminating cases there is no question of the inflammation becoming localised; it is an intensely virulent peritonitis involving one segment of the abdomen. Delay will only lead to the invasion of the whole cavity, and to a certain fatal issue. Hence

Rule 1.—*Every case of fulminating appendicitis should be operated on promptly; the cause—an acutely inflamed, perforated, or gangrenous appendix, will probably be easily found and must be excised.* The septic, half-purulent fluid should be removed, and free drainage must be provided. Subcutaneous or rectal injections of normal saline fluid will probably be found useful; the large intestine should be kept empty by turpentine enemata; the patient should be nursed more or less in the sitting position.

The cases just described are exceedingly grave, and fortunately exceptional; more common are those in which the onset is not so rapid, and the symptoms are less severe and alarming. We will suppose the surgeon called to see the case during the first twenty-four or thirty-six hours, when there is local pain and rigidity, but no general distension, and before there is any abscess. The experience of the last few years has proved that immediate operation in skilled hands is very safe, though somewhat more risky than excision *à froid*, or during the interval between attacks. Immediate operation with excision of the appendix will save the patient a certain amount of time and the necessity for a future operation. It will also remove the danger attending the period of possible abscess formation. If done with care, there is no greater risk of a ventral hernia ensuing than after excision *à froid;* in other words, there is practically none. Hence

Rule 2.—*During the first twenty-four hours or so after the onset of an acute attack of appendicitis immediate operation is advisable.* The methods are described on pages 408–414. The only difference will be that a certain amount of pus or fluid may be encountered, and should be carefully removed. A small drainage tube must be inserted at the lower end of the wound (after excision *à froid* drainage is rarely necessary).

The operation always includes removal of the appendix.

Unfortunately the surgeon rarely sees the patient until a few days have elapsed from the onset of symptoms, perhaps not until there is a well-developed abscess. It is under these conditions that the greatest difference of opinion exists as to the necessity for and scope of an operation. When the cæcum, appendix, omentum and coils of small intestine are matted together, forming the walls of a foul abscess, the identification and removal of the appendix may be attended with the greatest difficulty and risk. Indeed, even the evacuation of an appendix abscess may be a most serious proceeding. In a few cases, as Mr. Battle points out (*Practitioner*, December, 1907), it is better to allow an abscess to open into the intestine rather than to interfere surgically. And, moreover, it is certain that in many cases of limited appendix abscess the pus may be quietly absorbed. Still, wherever there is good reason to believe that pus is present, and increasing in amount (the patient being watched, and under careful treatment for a few days), the abscess should be drained. The site of the opening should in the great majority be placed in the right iliac fossa, near Poupart's ligament. Sometimes a rectal incision is advisable (when the abscess is intrapelvic and is felt to bulge against the rectal wall). We would here urge the importance of making a digital examination *per rectum* in every case of suspected appendix abscess.

In some cases the abscess extends backwards, and may well be opened above the crest of the ilium; in fact, as far back as possible to facilitate drainage. In a subsequent paragraph (p. 402) reference will be made to an incision deliberately placed in the lumbar region. This does not appeal to us as being a convenient route.

In the great majority a definite lump will be felt in the left iliac fossa near the anterior superior spine. A short incision, from one to two inches long, is made over the lump. The muscles are cautiously dissected through (the deep ones are sometimes matted together and the peritoneum is difficult to recognise). If the abscess-wall is formed in front by the parietal peritoneum, a small opening into it is made large enough to admit the end

of a pair of dressing forceps, by which it is then stretched. If the patient has not already been turned somewhat on his right side by means of a sand-bag or pillow behind the back, this should be done before the pus is let out. It is a convenient plan to hold aside the edges of the small incision in the external oblique, etc., by two pairs of Wells' forceps. The pus is now evacuated and the right index finger gently introduced. The object of this is two-fold—to ascertain whether the appendix can be identified, and whether a loose fæcal concretion is present in the abscess cavity. If the latter is felt it should be removed, or else it may be the cause of a persisting sinus.

In a large proportion of cases the abscess lies deeply in the iliac fossa, or it may be at the brim of the pelvis. In either case the incision in the abdominal wall must be enlarged, and sponge or gauze-packing inserted so as to prevent the pus from escaping widely into the peritoneal cavity. The deep abscess is now opened by breaking down adhesions with the point of the finger.

If the appendix is easily found, *i.e.* if it is comparatively free in the abscess cavity, it should be removed in the following manner. An aneurysm needle carrying a double fine silk thread is passed through the mesentery of the appendix close to the latter, and as near its cæcal attachment as possible. The needle is withdrawn, the thread divided in two, one half is tightly tied round the meso-appendix, the other round the appendix itself. Both parts beyond the ligature are then cut off; it is rarely possible to bury the stump of the appendix as in the interval-operation (p. 412).

The proportion of cases in which the appendix will be thus removed during the abscess stage varies with different operators. Mr. G. R. Turner puts it at rather over 50 per cent.; we should incline to a lower figure than that.

In every case, whether the appendix has been removed or not, a fair-sized drainage tube must be inserted to the bottom of the abscess cavity, the other end being cut flush with the skin and secured to it by a silkworm-gut suture. If the abscess is deeply placed a packing of gauze is left round the tube. There should

be no haste to remove either gauze or tube. The former is gently drawn out bit by bit from the third to the seventh day, the tube being removed still later. If the abdominal incision requires it, one or two silkworm-gut sutures are inserted through the whole thickness of skin and muscles to narrow the wound at either end. But care should be taken to leave the drainage free.

In the after-treatment the position of the patient is so arranged that the right iliac fossa is dependent, *i.e.* he is kept on the right side with the thorax raised on pillows. No food by the mouth until sickness has stopped; rectal infusions or nutrient enemata at first, then the cautious administration of fluid food in small quantities. If flatulent distension comes on, an enema containing one or two ounces of turpentine should be tried, and calomel (one to two grains) with four grains of salol may be given as an aperient about the third day.

If the pus continues to be free and foul after several days, irrigation should be carried out gently through the tube, a weak solution of iodine, or sanitas, or peroxide of hydrogen solution being suitable fluids. At the time of operation we often insert a double (two-way) rubber tube, as irrigation is more easily carried out through it than through a single one.

On no account should irrigation be employed unless and until the surgeon is sure the abscess cavity is well shut off from the general peritoneal one, and then the fluid must only be gently syringed through and not forcibly thrown in.

The Lumbar Operation for Appendix Abscess.—The following is abstracted from a paper by Mr. Sheldon (*Annals of Surgery*, 1904):—"The patient is placed in the latero-prone position with a large pad under the right loin, the cæcum then protrudes into the angle between the iliac crest and the outer border of the quadratus lumborum muscle." An incision is made from half an inch behind the highest point of the iliac crest towards the tip of the last rib. The anterior border of the latissimus dorsi muscle is exposed and drawn inwards, the internal oblique and transversalis are divided to a slight extent, the transversalis

fascia, fat and peritoneum are then traversed, and the abscess sought for and drained.

We have had no experience of this method, and, apart from its affording dependent drainage, should not have thought it a convenient one. Mr. Sheldon, however, states that he has treated 58 cases by the lumbar incision, and that the abscess dries up sooner than when drained through an anterior incision. For exposure and removal of the appendix itself the lumbar route cannot be recommended.

Complications after Operation.—These may be numerous. In an admirable paper by Mr. Lett (*Med.-Chir. Trans.*, 1905, and *Lancet*, 1905, vol. i., p. 569), which was based on 1,000 cases treated in the London Hospital, no less than thirteen distinct complications were illustrated, and the list might even be extended. Either general peritonitis or a localised secondary abscess in the peritoneal cavity (*e.g.* subdiaphragmatic) is an important one, and may require a second operation.

Both these complications seem to be especially dangerous in children or young adult patients. A fæcal fistula is not infrequent, and varies much in gravity. Now and then it comes on very soon after the operation from sloughing of the cæcal wall—this is almost always fatal. More often a limited fæcal fistula develops many days after the opening of the abscess, and though it may persist for long it usually heals spontaneously. But in some of these cases (especially if the appendix was not found at the time of opening the abscess), the surgeon should intervene through a fresh incision in order to remove the appendix or to close the opening in the gut. Such operations may be difficult and not always satisfactory; on the other hand, they may give excellent results, and the attempt is worth making.

We may condense the preceding into—

Rule 3.—*During an attack of appendicitis, if the local and general symptoms point to the presence of an abscess, this should (with few exceptions) be opened at the most convenient spot and drained.* During the operation the abdominal wall should be incised just enough to allow exploration with the finger. If the

appendix is readily found it should be removed; if not, the surgeon should be content with free drainage.

Any fæcal concretion that has escaped into the abscess cavity should be removed.

REMOVAL OF THE APPENDIX DURING A QUIESCENT PERIOD

An important question remains after the patient has recovered from his attack of suppurative appendicitis, supposing the cause has not been removed: Should a later operation be performed in order to excise the appendix? The advocates of abstention urge that in only about 20 per cent. of such cases does a further attack occur. On the other hand, it is certain that in some cases a later attack does occur, and may prove fatal. Our own experience has been this: a later operation has repeatedly shown that a most dangerous condition of the appendix persisted, and that the slight risk was fully justified. On the other hand, now and then, the appendix appeared to have been wholly destroyed, and the operation was useless.

On the whole, we recommend that the operation should be advised, putting the chances fairly before the patient, and allowing him to decide.

We come now to the most frequent and most successful form of operation for recurring appendicitis—the removal of the appendix during a quiet interval.

This should be urged when a single well-marked attack has been recovered from, when a series of recurrent attacks, however slight, has been experienced, or when local discomfort or pain on exertion point to slumbering mischief about the appendix.

The operation for the removal of the diseased vermiform appendix during a quiescent period when all inflammatory symptoms have subsided was first advised in 1887 by the original author of this work, who has dealt very fully with the circumstances and procedure (*Med.-Chir. Trans.*, vol. lxxi., p. 165; *Lancet*, Feb. 9th, 1889; *Brit. Med. Journ.*, Nov. 9th, 1889;

"The Surgical Treatment of Appendicitis," London, 1890; *Brit. Med. Journ.* and *Lancet*, June 28th, 1902).

The risk attending this operation during the quiescent stage —*i.e.* at least three or four weeks after the symptoms of an attack of appendicitis have subsided—is remarkably slight, though its difficulties in certain cases are not to be under-rated. Treves operated on over 1,000 such cases with two deaths, and the mortality under all conditions may therefore be put down as 1 in 500.

Anatomical Points.—In a small minority of cases the appendix can be felt through the anterior abdominal wall before operation. Fallacies are many with regard to this matter, the chief ones being the mistake of a lump of inflamed omentum or the outer edge of the rectus muscle for the appendix. "McBurney's point," which is so often referred to in this connection, is incorrectly supposed to localise the appendix at a point about two inches from the right anterior superior spine on a line drawn between it and the umbilicus. At this point, whether appendicitis has occurred or not, the individual is usually tender or sensitive to direct pressure. This, however, by no means indicates that the appendix is situated beneath this spot. As the researches of Dr. A. Keith have shown (*see* Fig. 113), in the majority of cases the ileo-cæcal valve corresponds to the spino-umbilical line, and the root of the appendix will be placed more than one inch lower down and perhaps internally to it. The ileo-cæcal valve in a normal person is usually tender to pressure.

In the great majority of subjects (nine out of ten) the sacculus of the cæcum on the right side of the longitudinal band is larger than that on the left, and hence the attachment of the appendix may be approximated to the ileo-cæcal junction. A most useful guide is formed by the three longitudinal muscular bands, either of which if traced downwards must lead to the appendix.

In most cases the appendix has a distinct mesentery in which runs its artery—the termination of the ileo-colic. This mesentery (meso-appendix) when present is always derived from the posterior surface of that of the ileum.

In some instances the appendix is tied down to the iliac fossa. Its average length is $3\frac{1}{2}$ inches, but it may be as short as half an inch or as long as six inches.

The most frequent positions for the appendix (which, of course, vary from time to time in the same individual) are (1) curved

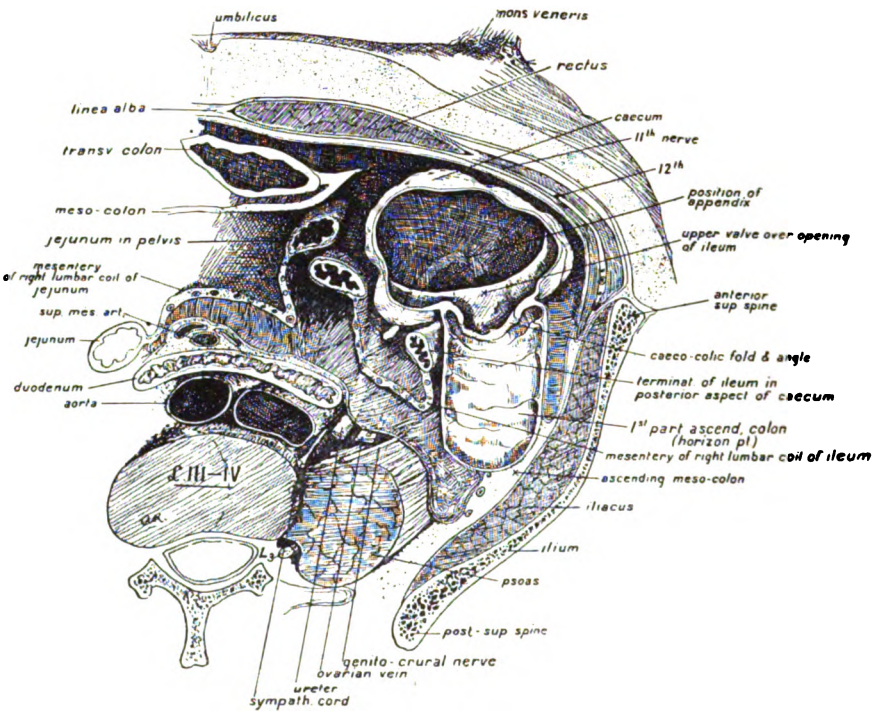


FIG. 113.—SECTION PASSING THROUGH A LINE DRAWN FROM THE ANTERIOR SUPERIOR ILIAC SPINE TO THE UMBILICUS.

The section passes through the ileo-cæcal opening, and lies wholly above the vermiform appendix.

or coiling upwards and inwards behind the end of the ileum (Fig. 114, A); (2) over the brim of the pelvis and external iliac vessels, to which it may closely adhere (Fig. 114, C); (3) downwards and inwards behind and just above Poupart's ligament, and, more rarely (4), upwards along the outer margin of the cæcum and ascending colon (Fig. 114, B), occasionally reaching in front

of the kidney up to the gall-bladder level; and (5) upwards directly behind the cæcum, by which it is entirely concealed (Fig. 114, D).

In stating that the position of the appendix may vary from

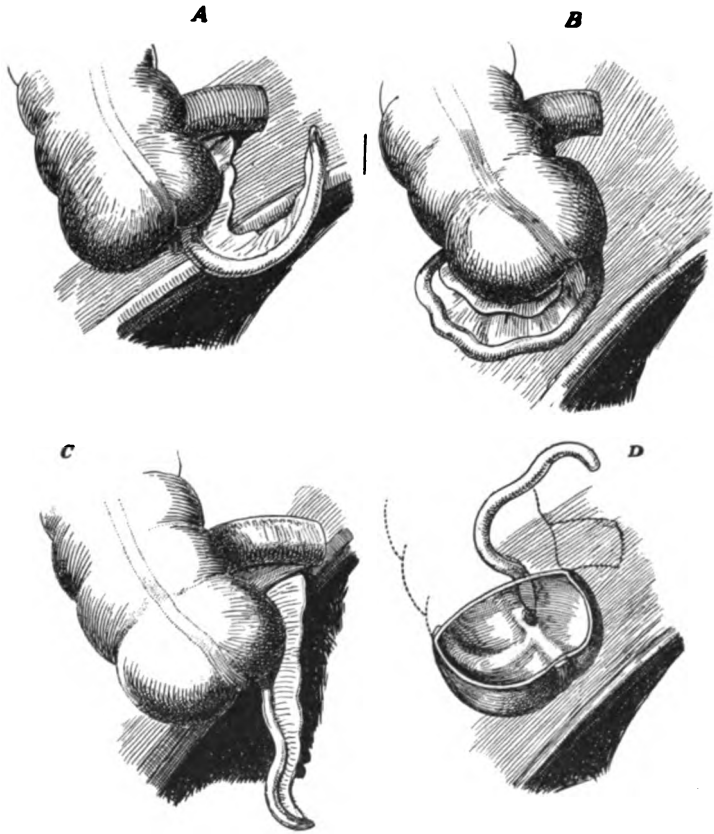


FIG. 114.—VARIOUS POSITIONS IN WHICH THE APPENDIX MAY BE FOUND. (*After Testut.*)

A, Lying over the external iliac artery and curving upwards; B, Curving to the outer side of the cæcum with its tip directed upwards; C, Hanging down into the true pelvis; D, Lying behind and concealed by the cæcum. The meso-appendix is shown in A, B, and C.

time to time in the same subject, an exception must be made for the cases in which it is tied down by congenital or acquired peritoneal adhesions. For example, the vertically placed appendix running up at the outer side of the colon is usually completely

buried by adhesions. In other cases a firm meso-appendix may tie down the middle of the organ to the iliac fossa. This is a fertile cause of kinking and inflammation in the distal half.

The appendix is supplied with blood by the posterior ileo-cæcal artery, a vessel which passes behind the end of the ileum to reach its destination. The artery to the appendix enters the meso-appendix and divides into three branches. The largest runs in the free edge of the meso-appendix and reaches the tip of the vermiform process. The other two reach the appendix at intervals of about half an inch. For the minute anatomy of the appendix see Fig. 115.

Preparation of the Patient.—A simple and somewhat restricted diet should be enjoined for a few days; the bowels should be thoroughly cleared with aperient and enema, and the usual antiseptic preparation of the skin carried out.

The patient lies flat upon the operating table, or the pelvis may be slightly raised. Some surgeons even advocate the Trendelenburg position, but this is unnecessary and inconvenient in the majority of cases, and should be reserved for those of exceptional difficulty (*see* page 410).

The Incision.—The incision is about two inches in length, and is made obliquely across the line which joins the anterior superior iliac spine and the umbilicus. It is placed externally to the semilunar line. The lower and inner end of the incision sometimes crosses the edge of the rectus, but as a rule it is quite external to this. The external oblique is cleanly divided for the full two inches, parallel to the direction of its fibres. The two edges are held aside, and the internal oblique and transversalis traversed by an incision crossing the line of the external incision, *i.e.* dividing hardly any or none of the muscular fibres. For the average case ample room is thus provided, and subsequent risk of ventral hernia is entirely obviated. But if special difficulty is met with the muscular incision should be enlarged. The peritoneum is divided with care, as the cæcum, ileum, or omentum may be adherent to the anterior abdominal wall at the point of the incision. The

divided peritoneum on either side of the wound is neatly picked up with pressure forceps, and as these are drawn upon they act as retractors and facilitate the introduction of the fingers into the abdomen. Two fingers of the right hand are passed into the cavity, and the cæcal region is examined. In the female subject this examination should always include the right ovary.

Demonstrating the Appendix.—The cæcum is sought for and is gently drawn out of the wound by means of the two fingers. As a rule, this is readily done when there are no adhesions, and in such case the appendix is at once demonstrated. In a large proportion of cases, however, there are difficulties due to adhesions. The whole area should be well examined with the fingers, and the wound enlarged if necessary. The simplest way of finding the appendix is to identify the cæcum and the terminal part of the ileum, and where these two meet, the appendix will be found. The separation of the adherent appendix is often tedious. Care must be taken in clearing it if it runs inwards and adheres to the tissues covering the iliac artery and vein and the ureter. Especial care is necessary when the ileum is closely involved in the adhesions. The adherent appendix may open by one or more ulcerations into the cæcum, colon, ileum, or rectum, and the apertures left in these viscera by the removal of the appendix must be carefully closed. The appendix is often adherent to the ovary or the broad ligament, and occasionally it is attached to the bladder. In one of our cases it opened into the interior of the bladder. The diseased structure may be buried in a mass of omentum, or may be closely united to the mesentery, or be buried in dense and almost cartilaginous tissue in the iliac fossa. It may extend upwards, and its tip be found under the liver, and it has been known to adhere to the gall-bladder. A large proportion of the adhesions encountered are dealt with by the fingers. There must be no tearing, and no dragging of tissues apart with two pairs of dissecting forceps. The blunt dissector is often useful. All resisting adhesions should be well defined and then cut with scissors or a scalpel. Adherent tags or lumps of great omentum should always be excised, due care

being paid to ligature of their vessels. Now and then the infected and inflamed piece of omentum is converted into an oval uniform lump. In all these preliminary measures the operator should observe the rule to keep close to the appendix, and, above all, seek for its tip. The free end of the appendix is the key of the position when adhesions are very troublesome. When once that is found, the difficulties are nearly over.

In many cases of difficulty it is well to divide the undisturbed peritoneum of the right iliac fossa well to the outer side of the disturbed area; by working along in the retroperitoneal tissue the surgeon reaches the adherent bowel, and can readily detach it, stripping off the peritoneum with it. The operator should never drag upon adherent bowel, especially upon adherent ileum. The only structure upon which considerable traction may safely be made is the appendix. This organ is apt to be much contorted, and is often bent acutely upon itself. Small caseous or even calcareous glands in the mesentery of the ileum are apt to mislead the operator when adhesions are widespread. A small hard gland may be mistaken for the end of the appendix. Even Meckel's diverticulum has been met with involved in the adhesions around a diseased appendix. It was excised close to its origin from the ileum. The most difficult adhesions are met with when the appendix passes into the true pelvis, and is possibly in communication with the rectum. A good electric light, a full retraction of the margins of the wound, a very free incision, and the Trendelenburg position are necessary in these very troublesome cases.

In dealing with such instances, the rule should always be observed to keep throughout very close to the appendix, which must be followed as a guide.

In detaching an adherent appendix an abscess cavity may be discovered. It will probably communicate with the bowel. It should be well sponged out, and its walls gently scraped. Some surgeons attach importance to dusting the involved area with an antiseptic powder, such as iodoform, aristol, etc. The value of this procedure is very doubtful, and it may even do harm.

In certain of these cases, but not in all, a drain will be needed. A considerable amount of pale-yellow, custard-like material may be found about an adherent appendix. It should be carefully scraped away. Caseous glands, if readily isolated, should be removed whenever possible.

Treatment of the Pedicle.—As the appendix is being isolated, care should be taken to demonstrate its pedicle. The pedicle represents the meso-appendix, or at least the source of the blood

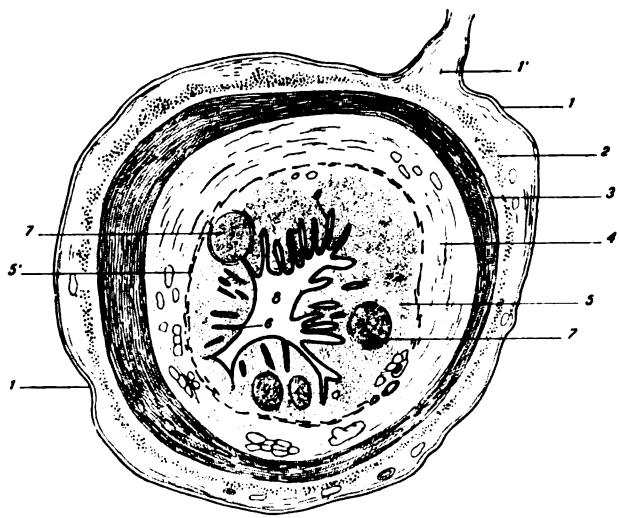


FIG. 115.—SECTION OF VERMIFORM APPENDIX FROM A YOUNG ADULT. (*After Testut.*)

1, Peritoneal coat, reflected at 1' as the meso-appendix; 2, Subperitoneal coat, with vessels and longitudinal muscle fibres; 3, Circular muscular coat; 4, Submucous layer; 5, Mucous layer, with glandular crypts, tubules, and closed follicles; 5', Muscularis mucosæ; 6, Tubular glands; 7, Lymphoid follicles; 8, Lumen of appendix.

supply of the appendix (Fig. 115, 1'). There may be no meso-appendix. The appendix may derive its blood supply direct from cæcal arteries, or direct from adhesions. It may be supplied apparently wholly from adherent omentum. Sometimes the appendix is found to be fibrous and shrunken, and in such case its blood supply may be very small. Such an appendix may be removed without securing any vessels by ligature, but this is very rarely the case.

In an uncomplicated case the appendix and its mesentery

are readily brought out of the wound, and the rest of the operation may be described as it would apply to such a case. The end of the cæcum, the appendix, and perhaps the termination of the ileum are now the only exposed parts in the wound; they are laid on a sterile gauze-pad or sponge, any other part of intestine or omentum being returned within the abdomen. The meso-appendix is spread out. When the organ is involved in the cæcal fossæ, this may not be readily done until the folds of peritoneum which hide the meso-appendix are neatly divided. These folds do not represent adhesions. Close to the base of the appendix a gap will always be noticed between the blood-vessels going to the little tube. The meso-appendix is perforated at this gap, and a silk ligature is passed through by means of an aneurysm needle or a pair of forceps. This ligature will suffice to secure the meso-appendix when it is small. When it is wide the membrane and its vessels should be secured by two silk ligatures. The meso-appendix is now divided between the ligature or ligatures and the appendix. Before it is cut, the meso-appendix on the proximal side of the ligatures is secured by pressure forceps to prevent it from slipping. The divided meso-appendix may need a second ligature before these forceps are detached and the stump is allowed to drop back. When the appendix is adherent the adhesions are dealt with similarly, and the organ about to be removed is entirely freed from its boold vessels.

Removal of the Appendix.—A ligature must be applied at the very base of the appendix. This ligature may be secured —if thought well—before the meso-appendix is dealt with. The ligature is of silk, and is passed through the gap between the vessels to which attention has been directed. The peritoneum is divided with a scalpel in a circular manner, at the point at which the ligature will come. The serous membrane is just sufficiently turned back to make room for the ligature. In many cases, if the circular cut is carefully taken into the submucous layer (Fig. 115, 4) a satisfactory cuff formed chiefly of peritoneal and muscular layers can be reflected for a short distance. Its reflection certainly makes the insertion of the Lembert

sutures easier, and also the application of the constricting ligature at the highest possible point. The ligature is securely tied. The appendix is then cut off with scissors close to the ligature. The scissors thus used are at once put aside, and must not be employed again until they have been freed of infection. The stump of mucous membrane is trimmed down, and the instrument or instruments used are put aside, as they will be infected. The practice of applying the actual cautery or pure carbolic acid to the appendix stump is to be condemned. So long as the divided stump is exposed it is held in position by the ligature which encircles it. The utmost care must be taken that it touches nothing. If it accidentally touches the parietal wound, the wound is quite likely to give trouble later on. The stump is now sequestrated by a series of Lembert's sutures, made of fine silk. The sutures involve the cæcal wall around the stump of the appendix. The stump is thus inturned and hidden from view, and is perfectly secured. To cover the stump with a hood or flap of peritoneum derived from the appendix itself is not always either possible or desirable. All ligatures are cut short, and the cæcum is returned into the abdomen. Occasionally the peritoneal coat of the cæcum is not available for helping to cover in the appendix stump. In such an instance it is easy to find suitable serous membrane in the vicinity.

It is important that the appendix should be divided as close to the cæcum as is possible. The stricture which has caused the trouble may be at the orifice of the appendix. The following case serves to illustrate this point. In a young man of twenty a surgeon "removed" the appendix for the relief of recurrent appendicitis. In spite of the operation, the attacks continued precisely as before; the abdomen was again opened, and it was found that the previous operator had left a stump of appendix which measured three-quarters of an inch in length. This was much distended, and was strictured at its origin from the cæcum. The stump was removed, and the attacks ceased. In another instance the appendix was closely adherent to the cæcum, and had evidently been bent acutely upon itself. The surgeon had

removed that part of the appendix which projected from the cæcal wall. The proximal part, which was fixed to the cæcum and buried in adhesions, had been left behind. This segment measured one inch, and had given continual trouble.

Closure of the Wound.—Small blunt hooks are introduced into the ends of the wound, and by means of them the edges of the wound are kept in perfect line, and the parietes are withdrawn from the subjacent viscera. The pressure forceps, which still hold the cut edges of the peritoneum, are removed by cutting away the little tag of (damaged) peritoneum which they grip between their blades. The peritoneum is united by a continuous catgut suture. The rest of the wound is closed by means of silkworm-gut sutures, involving the skin and the muscles, which are neatly picked up in precise order. In muscular subjects the muscles may be separately united by a series of buried sutures of kangaroo tendon. In such cases there will therefore be a line of sutures for the peritoneum, for the muscles, and for the skin respectively.

On the whole we prefer the method of four-layer suture. Certainly it is essential to suture the peritoneal layer separately —as it is important to prevent adhesions in future, and without the suture the two cut edges are apt to gape considerably. If the transversalis and internal oblique have been at all divided or widely separated two or three deep tendon or catgut sutures should be inserted. The external oblique must be sutured separately and carefully. It is easy to incur the reproach of excessive care in the matter of closure of an abdominal wound, but attention to such details and five minutes spent over them may make the difference between an absolutely sound abdominal scar and one that subsequently yields. From the experience of many hundred cases we affirm that a ventral hernia after removal of the appendix *à froid* should never occur, and that its development is a proof that the operator's method of closing the abdominal wound was an imperfect one. Of course this does not apply to the cases where an abscess has been drained.

Notes on the Operation.—As a rule the removal of the vermi-

form appendix during the interval is a simple and very satisfactory operation. The patient needs only to remain in bed for a fortnight after it, a light diet being given, and constipation guarded against.

It is, however, impossible to predict what difficulties will be met with during the operation, and occasionally the operator's skill and patience are tested to the utmost. When firm adhesions have given much trouble, or when an abscess has been found about the appendix, it is generally best to insert a small drainage-tube at one end of the wound; this need not interfere with sound closure of the rest of it. The tube is left in for several days. In the great majority of cases, however, no drain is required.

Many operators use a small clamp for crushing the base of the appendix before applying the constricting ligature. There is no special advantage in this.

Mr. Battle, Professor Roux, and others, have advocated that the abdominal incision should as a rule be made over the outer edge of the rectus muscle. The wound is a nearly vertical one.

The sheath of the rectus muscle being opened, it is drawn inwards, and the posterior layer of the sheath, transversalis fascia, and peritoneum divided. The incision is perhaps especially adapted for cases in which the appendix dips towards the pelvis, or where special difficulty is expected and a long incision required. It is claimed in its favour that however long the incision, there is no risk of a ventral hernia ensuing, as the rectus muscle comes over the weak spot. If this incision be adopted, the position of the deep epigastric vessels must be kept in mind. If one or more nerves entering the rectus muscle at its outer edge are seen, they should be spared division if possible.

Although this incision through the rectus sheath is widely employed, our personal experience of it has not been very favourable. Its use may cramp the operator in getting at the appendix when the latter lies in the outer part of the iliac fossa. It is distinctly more difficult to sew up the peritoneum behind the rectus than in the other incision. Finally, the latter has the advantage that it is readily extended in any required direction,

and with careful suture—layer by layer—there is no fear of a ventral hernia resulting.

OMENTAL SUTURE (EPIPLOPEXY) FOR CIRRHOSIS OF THE LIVER

Mr. Rutherford Morison in England devised and practised this operation with the view of relieving the portal congestion by providing anastomotic channels between the omental veins and those of the anterior abdominal wall.

Soon afterwards, M. Talma independently described the same procedure—and hence it is often known as the Talma-Morison operation, though Epiplopexy is a far better name. M. Monprofit has written an elaborate monograph on the subject, with details of upwards of 200 cases.

Whether the operation has given sufficient benefit to justify its continued performance is somewhat doubtful. It has a heavy mortality—33 per cent. (Sinclair White's collected statistics, *Brit. Med. Journ.*, September, 1906). Of the cases which recover about one-half are not improved by the operation. This leaves the small proportion of one in three cases in which anything like a cure has followed the operation. And it must be remembered that spontaneous improvement or recovery is not unknown after simple tapping, provided the alcoholic habit is completely discarded by the patient.

Before the operation is decided on the following points are worthy of note :—

1. The cases should be carefully selected. If there is no prospect of the patient giving up entirely the use of alcoholic stimulants the operation can only end in disappointment.

2. The existence of other visceral disease (cardiac failure or chronic nephritis, for example) should negative the idea of operation. The subjects of alcoholic cirrhosis of the liver are among the very worst for any surgical procedure.

3. The operation at best can only increase to a slight extent the collateral circulation which normally exists between the small peripheral branches of the portal and systemic veins.

4. The operation has the drawback of leaving an omental band which may subsequently give trouble, and of favouring the occurrence of ventral hernia.

The Operation.—An incision is made through the abdominal wall, slightly to the right of the middle line, with its lower end opposite to the umbilicus. The ascitic fluid is gradually evacuated and the incision enlarged to about four inches. The right edge of the wound is held aside, and an area of the peritoneal surface is scarified or briskly rubbed. The omentum is then fixed to this area by a few catgut sutures, and the abdominal wound is carefully closed layer by layer. Some silkworm-gut sutures should be made to traverse both skin and aponeurosis, and should be firmly secured by double knots. These should be left in for at least a fortnight, as it is of importance to secure firm union. The ascitic fluid will probably collect again in a few days, and there is a marked tendency for the scar to yield. It is well to secure the dressings by an elastic bandage.

Note.—The incision is placed in the upper part of the abdomen, as the omentum may be short, and if the latter be fixed low down to the abdominal wall it might form a tight band. It has often been necessary to resort to frequent tapping after the operation, for the relief afforded by the anastomotic veins is only slight in the majority of cases.

CHAPTER XIV

OPERATIONS ON THE SPLEEN

SPLENECTOMY

SPLENECTOMY, or extirpation of the spleen, has been carried out in cases of injury or prolapse of the spleen, in certain instances of movable spleen, in simple hypertrophy of the organ, in "Banti's disease," and in some cases of tumour of the spleen, etc. The indications for the operation will be considered with its prognosis at the end of this chapter (p. 423).

The history of the operation is thus given by Sir Spencer Wells in his "Surgical Treatment of Abdominal Tumours" (p. 182):—"I think we may look upon the case of extirpation of the spleen attributed to Zaccarelli in 1549 as apocryphal. We do not find anything authentic till 1826, in which year Quittenbaum, of Rostock, removed a diseased spleen from a woman, who died of shock in six hours. Then, in 1855, Kückler, of Darmstadt, reported that he had done the operation on a man who had enlarged spleen from ague. He encountered no special difficulty in his undertaking, but lost the patient from hæmorrhage two hours after operation." The first operation in England was performed by Sir Spencer Wells in 1865. The patient lived six days. Péan, who operated in 1867, had what may be termed the first successful result in modern times. Since then the operation has been extensively practised, and with a considerable degree of success.

Anatomical Points.—The spleen most closely approaches the surface in the parts covered by the tenth and eleventh ribs. Above this it is entirely overlapped by the edge of the lung. It is in all parts—when of normal size—separated from the parietes by the diaphragm.

Its long axis coincides very nearly with the line of the tenth

rib. "Its highest and lowest points are on a level, respectively, with the ninth dorsal and first lumbar spines; its inner end is distant about one and a half inches from the median plane of the body, and its outer end about reaches the mid-axillary line" (Quain).

The three surfaces of the spleen—gastric, renal, and phrenic—are well shown in Fig. 116.

The peritoneum which invests the spleen is reflected at the

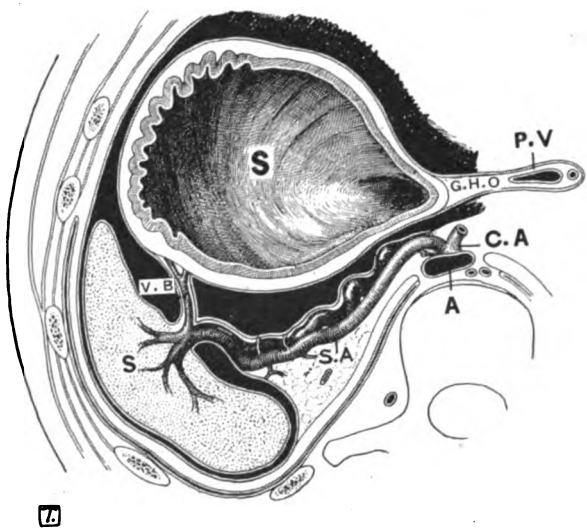


FIG. 116.—RELATIONS AND VASCULAR SUPPLY OF THE SPLEEN (S). (*After Testut.*)

S.A., Splenic artery derived from C.A., the cœliac axis. V.B., Vasa brevia from splenic artery to stomach. G.H.O., Gastro-hepatic omentum containing P.V., the portal vein. A, The aorta.

hilum, and passing on to the stomach forms the gastro-splenic omentum. This omentum contains the splenic and other vessels, and forms the pedicle, which has to be dealt with when the organ is excised. The splenic artery breaks up into branches—which vary from five to seven in number—just before it reaches the gland. These branches vary in length and size, and will probably have to be dealt with individually in cases of great enlargement.

The vasa brevia, from four to six in number, are directed

forwards and to the right, and lie also in the gastro-splenic omentum. Some issue from the trunk of the splenic artery, some from its terminal branches. They all reach the left extremity of the stomach. Some or all of these branches may be divided in the pedicle.

The gastro-epiploica sinistra artery also occupies the gastro-splenic omentum for a small part of its course.

The splenic vein is placed below the artery. Its tributaries correspond to the branches of the artery, and the trunk of the vessel is of considerable size.

The comparative thinness of the spleen capsule, and the peculiar friability of the splenic tissue, must be borne in mind.

Instruments Required.—Those required for ovariotomy, with the exception of such special instruments as the ovarian trocar. Four or more good clamps must be at hand.

The Operation.—The parietal incision is conveniently made along the outer edge of the left rectus muscle. It is vertical, and may need to be of considerable length. Its upper extremity should lie near to the ribs. If this vertical incision is found not to be sufficient a second should be added, passing from its centre well outwards into the loin. In many of the reported cases a median incision has been made use of, and in dealing with very large tumours it is perhaps the more convenient.

The peritoneum having been opened, the tumour is examined. If any adhesions exist, they must be at once dealt with. If very extensive adhesions are discovered, which serve to connect the spleen with adjacent viscera, and to obscure the anatomical details of the part, the operation had probably better be abandoned. The omentum is not unfrequently found to be adherent to the tumour, and some trouble has arisen from the accidental division of the large vessels which may be found in that structure. The veins in those peritoneal bands which are connected with the spleen are in some cases greatly enlarged, and care should be taken that they are well secured between two clamps before division. The lieno-renal and lieno-phrenic ligaments require special attention.

The enlarged spleen is now gently drawn through the wound. The organ must be handled with the greatest care, and any attempts to force it through a comparatively small incision must be avoided. The spleen has sometimes been ruptured during removal as the result of too severe pressure brought to bear upon it.

The tumour must be allowed to escape slowly, and as it protrudes the pedicle must be from time to time inspected, lest undue traction be made upon the vessels therein, and especially upon the thin-walled veins.

Dragging upon the pedicle has produced alarming symptoms of collapse, due, no doubt, to injury to the splenic nerve plexus, which is derived from the solar plexus.

The most important feature of the whole operation is concerned with the treatment of the pedicle.

A clamp should be applied at a short distance from the spleen so as to include both splenic artery and vein in its grasp. In fixing the clamp care must be taken not to include or damage the tail of the pancreas or the stomach wall. A second clamp applied close to the spleen will render ligature of the vessels between them easy.

By means of a large blunt aneurysm needle ligatures can then be carried round the pedicle vessels on the distal side of the clamp and tied securely. The danger of cutting through the vessel walls if too much force be used should be remembered. Nothing is better than kangaroo tendon for the ligatures, though as a rule silk has been employed. After the spleen has been removed the clamps should be carefully relaxed, and any additional ligatures applied that are necessary.

In more than one case a small artery has slipped out from its ligature, and severe bleeding, difficult to check, has followed.

Some surgeons tie the pedicle in two intertwined ligatures and then add a separate ligature around the whole stump.

No special advantage has been shown to attend the practice of ligaturing the artery and the vein separately.

Care must be taken that the structures of the pedicle are

relaxed at the moment that each ligature is tied. It is better to err in the direction of applying too many ligatures than to attempt to include the whole pedicle in one or even two knots. The ideal method—if time ever permitted—would be to tie each vessel separately.

In dealing with the pedicle, the pancreas has been wounded, and the tip or tail of that organ has even been included in the ligature.

The ligatures having been all cut short, the peritoneal cavity is well cleansed, and the abdominal wound is closed.

The movable or wandering spleen can very seldom indeed require to be removed. It gives trouble not by mere wandering, but by becoming twisted on its pedicle. The rotation of the pedicle may be such that all blood supply from the splenic artery is cut off, and the organ receives its nourishment through adhesions mainly of the omentum. I have in two instances exposed a movable spleen which had become twisted on its pedicle. In one case the organ was in the pelvis, was easily felt *per rectum*, and was supposed to be a congenital sacro-coccygeal tumour. In the other instance it was in the left iliac region, and had been diagnosed as an ovarian cyst. In both cases perfect relief of all symptoms followed the operation, which was represented by untwisting the pedicle as far as was possible, by dividing adhesions likely to cause trouble, by separating intestine which might have become compressed or kinked, and by so securing the pedicle by numerous sutures that further rotation could not occur. In the latter of the two cases the spleen was the seat of an enormous infarct.

In some cases a wandering spleen has been secured in place to the parietes by sutures passing through the capsule, though the latter is so friable as a rule that it is difficult to prevent the sutures from cutting through.

Comment.—The great risk of the operation of splenectomy is hæmorrhage from the pedicle. In twenty-nine cases collected by Collier, no less than fourteen died directly from bleeding.

The treatment of the pedicle constitutes the main feature

of the operation, and next to it must rank the treatment of such adhesions as may exist.

Results.—Mr. Wright, of Manchester, has collected sixty-two cases of splenectomy. In twenty-two cases the operation was for leukæmia, and all the patients died. In twenty-three cases the spleen was the seat of simple hypertrophy, and fifteen patients died. Of seven who were operated on for malarial disease, five recovered; and of three on whom splenectomy was performed for cystic disease, all recovered (*Med. Chron.*, December, 1888).

In "Banti's disease" the spleen becomes large and hard, the patient is anæmic, and ultimately cirrhosis of the liver with ascites follows. Splenectomy appears to result in cure, and many cases have been recorded. Dr. G. E. Armstrong (*Brit. Med. Journ.*, Nov. 10th, 1906) collected thirty-two cases with nine deaths, but this percentage (twenty-eight) most certainly does not represent the real mortality of the operation, as it contains chiefly isolated cases published by various surgeons. The direct mortality of excision of the spleen for Banti's disease is probably at least 40 per cent. to 50 per cent., and the real value of the operation is still uncertain. The true nature of the disease is a mystery.

It is obvious that excision of the spleen as a method of treatment of leukæmia cannot be condemned too strongly, for in this condition the operation is simply deadly in its results. For simple hypertrophy it is not justifiable, and for malarial enlargement of the spleen excision is far too heroic a treatment. At present we know too little of the so-called Banti's disease to decide whether splenectomy should continue to be resorted to. It must be admitted that whilst malarial or leukæmic enlargement may, and not unfrequently does, subside under treatment by arsenic, iron, and other drugs, in Banti's disease no remedies appear to have any effect, and the progress is a slow and steady one towards death. But the very heavy mortality of the operation must be well borne in mind before resorting to it.

The chief indications for excision of the spleen are (1) a wandering state of the organ provided that it causes real and persistent trouble, or is complicated by torsion of the pedicle; and (2) traumatic rupture of the spleen.

An excellent review of the operation for rupture of the spleen has been given by Mr. Graham Simpson (*Clin. Soc. Trans.*, 1906, p. 33). He reports a case successfully operated on by him within six hours of the accident (a fall which produced fracture of one femur), and summarises seventy other cases recorded since 1890. Of these seventy cases twenty-eight proved fatal without operation, of the forty-two patients operated on fifteen (36 per cent.) died, and twenty-seven (64 per cent.) recovered. Mr. Simpson believes that this mortality is "probably much too favourable," and he points out how gravely the danger of the operation is increased by the existence of previous adhesions of the spleen. He regards exploratory operation as being indicated in every case in which rupture is suspected. The spleen has such important functions with regard to the blood that one would expect its sudden removal to be followed by serious effects. Fortunately the blood-marrow and the lymphatic glands appear to compensate for the loss of the spleen. Mr. Simpson writes:—

"The *sequelæ* of the operation of splenectomy present a most interesting problem.

"The majority show no abnormal effect except a transient anæmia and leucocytosis which swing back to normal in about a month, and an enlargement of the lymph-glands, most often the left axillary and inguinal; otherwise the patients are healthy.

"In two cases the patients, though pregnant at the time of operation, have gone on to term. Another patient was successfully operated on for a resulting ventral hernia. A fourth recovered from an attack of typhoid fever after losing his spleen.

"In five recorded cases (viz. those of Messrs. Ballance, Bernard Pitts, Rutherford Morison, Heaton and Burrows) a curious set of symptoms supervened on or after the tenth day; these were progressive emaciation (one case lost three stone), attacks of

epigastric pain, pyrexia, thirst, rapid pulse and respiration, headache, drowsiness and irritability of temper.

"These cases have cleared up on the exhibition of arsenic and sheep's spleens; in one case the patient relapsed when the treatment was discontinued.

"Mr. Ballance has suggested that these symptoms may be due to the fact that it takes some time for the other organs of the body to take over the functions of the spleen, and that it is less likely to occur in children, in whom the tissues are said to be less specialised. The latter part of his theory is not supported by the ages of the five cases which I have just referred to; they were 4, 9, 16, 36, and 45 years."

CHAPTER XV

OVARIOTOMY

History of the Operation.—Robert Houston, of Glasgow, treated an ovarian tumour by operation in 1701. The patient recovered, but the operation appears to have been represented merely by an incision into the cyst and the evacuation of its contents. The first complete and deliberate ovariotomy was carried out by Ephraim McDowell, of Kentucky, in 1809. The pedicle was secured by a ligature, the ends of which were brought out of the wound. The patient made an excellent recovery. In 1821 Nathan Smith, of Connecticut, who appears to have been ignorant of McDowell's work, performed a successful ovariotomy, in which he secured the pedicle with animal ligatures, which were cut short. The operation made great progress in America in the hands of Dunlap, Atlee, and others, and by the year 1850 at least thirty-six ovariotomies had been performed in that country, with twenty-one recoveries.

In Great Britain Lizars is reported as operating in 1824 and 1825, but his results were not encouraging. Granville operated in London in 1826 and 1827. In 1842 Charles Clay, of Manchester, commenced to perform ovariotomy. He carried out a large number of operations, and met with a fair degree of success. By the year 1850 ninety-one ovariotomies had been performed in Great Britain, with a mortality of 36.27 per cent. Spencer Wells performed his first complete ovariotomy in 1858, and Keith in 1862. For some years these surgeons were the two prominent figures in the development of ovariotomy, and it was under their hands mainly that the modern operation was evolved. Ovariotomy has now been shown to be one of the simplest and safest major operations in surgery, and there are

very few surgeons who have not had a personal experience of this measure.

The history of the operation is associated to a large extent with an account of the different manner in which the ovarian pedicle has been treated at different times. McDowell used a single ligature, and left the ends outside. Nathan Smith carried out the now accepted method of securing the pedicle with ligatures, which were cut short, and of dropping the stump into the abdomen.

Ovariotomy, the most frequently performed of abdominal operations, includes the procedure for the removal not only of ovarian tumours, but also of tumours of the parovarium, broad ligament, and Fallopian tubes.

Anatomical Points.—The following account of the surgical anatomy of the ovary, Fallopian tube, and broad ligament is taken from Doran's admirable work :—

Each *Fallopian tube* lies between the layers of the broad ligament, which are reflected over its upper surface and meet along its lower surface, when they are continued downwards towards the ovary. The serous membrane is held on to the tube by connective tissue, generally a little tenser and firmer than that which lies between the layers of the broad ligament lower down. Still, it is easily stripped off from the tube, whether by design or accident. The thin-walled cysts, so common in the folds of the broad ligament, are rare along this line of reflection over the tube ; and when they develop there they seldom, if ever, grow large.

The surgeon must not forget the fact that the ostium of the tube opens into the peritoneal cavity. Fortunately, inflammatory processes tend to close the ostium, and thus protect the peritoneum. If the tube be divided during an operation, care must be taken that the orifice on the proximal side is well closed. Each tube measures about four inches in length when not stretched artificially. It is seldom or never of the same length on the two sides. It becomes extended to an extreme degree in cases of simple broad ligament cysts which press against it.

The first inch from the fundus of the uterus outwards is straight and narrow; this is known as the isthmus. The remainder is dilated, and is called the ampulla. This terminates externally in the conspicuous fimbriated extremity, which surrounds the ostium, or opening of the tube into the peritoneal cavity. (*See* Fig. 118 and Plate XIV.)

The canal of the tube is very narrow at the isthmus, barely admitting a bristle, and is narrowest at its junction with the uterine cavity. Along the ampulla the canal is wider.

There can be no doubt that the Fallopian tube is naturally patent. Vaginal injections (as Dr. Matthews Duncan has shown) may pass into the peritoneal cavity and set up peritonitis.

Of the fimbriæ one is much longer and thinner than the rest, and is known as the ovarian fimbria. It runs on to the tissues of the ovary. It is a good guide when the parts are altered by new growths—indeed, the fimbriæ altogether are excellent landmarks. Unfortunately, they are rapidly obliterated in inflammatory diseases of the tube itself, and this may cause great confusion to the operator. The ovarian fimbria is extremely elongated in cases of simple broad ligament cyst.

The outer part of the Fallopian tube turns downwards externally to the ovary, so that its fimbriæ embrace to a certain extent the outer part of that organ. The ovarian fimbria runs upwards towards the ovary—not downwards to the ovary, as usually represented. This relation of the tube to the ovary accounts for the singular shape of a dropsical tube, which curves outside and a little below the ovary, and also for the position of the fœtal sac in cases of gestation in the outer part of the Fallopian tube, the sac lying not above the ovary, but outside, and often partly below it.

As the uterus always leans a little to one side, the ovary on that side hangs downwards more than its fellow, which is held almost horizontally between the ovarian and the infundibulo-pelvic ligaments.

The *ovary* is connected with the back of the broad ligament by its dense and tough hilum, which is invested by a plexus of

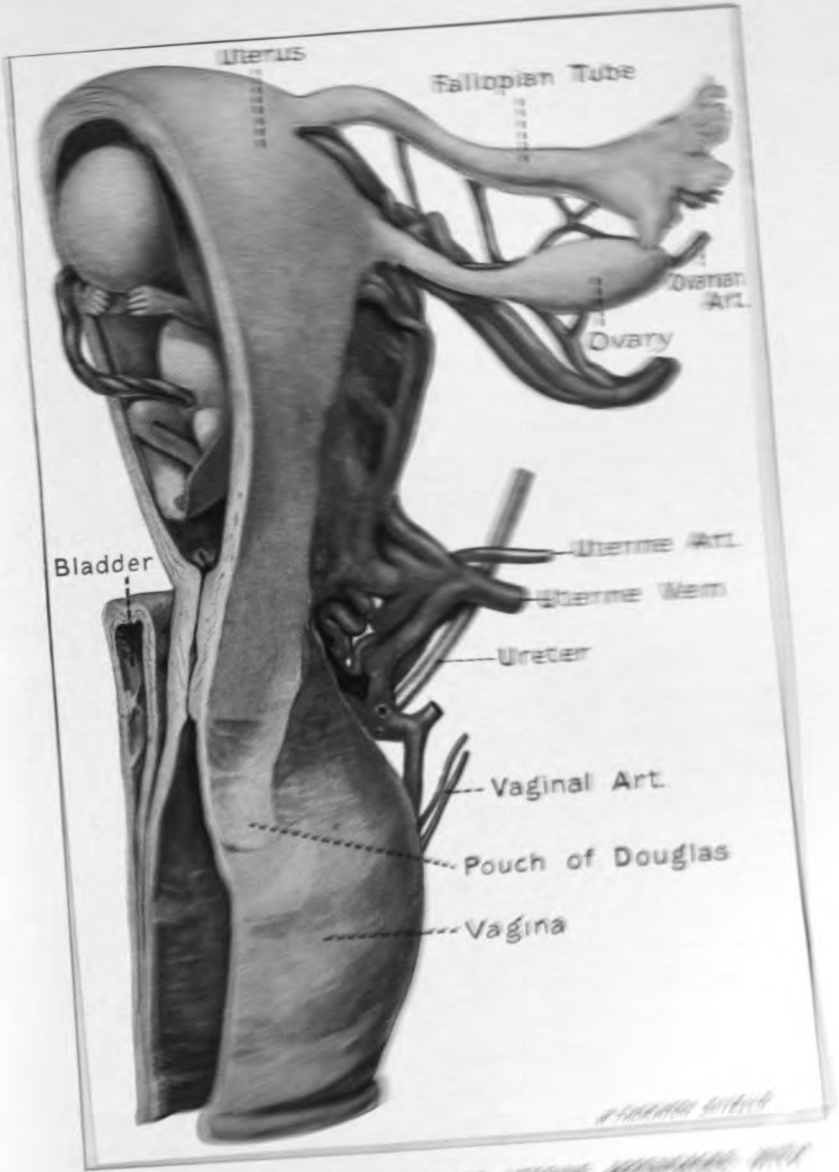


PLATE XIV—UTERUS, VAGINA, AND UTERINE [illegible]
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veins, the bulb of the ovary. As the tissue of the hilum is continuous with the connective tissue between the folds of the broad ligament, morbid growths, developed in its substance, tend to burrow into these folds. The parenchyma, or ovum-bearing part of the ovary, hangs behind the broad ligament. It is connected with the uterus by a prolongation of the muscular tissue of the latter called the ovarian ligament, and invested by an elevation of the peritoneum.

This ligament is an important landmark when the surgeon is engaged in exploring the appendages during an operation ; it is much stretched in cystic disease of the ovary, and generally hypertrophied in fibroid disease of the uterus.

The average weight of the normal ovary is at least 100 grains. Its long axis is a little over two inches, its short axis one inch, its thickness quite half an inch.

The reflection over the fundus uteri extends along each Fallopian tube, and outwards and backwards over the ovarian vessels. The layers of peritoneum meet, after investing the tube, to form the *broad ligament.* The fold over the ovarian vessels is slight, yet well marked, and is known as the infundibulo-pelvic ligament. It appears as a short fold of peritoneum, which runs from the brim of the pelvis to the ovary. It is described by Drs. Hart and Barbour as that part of the upper margin of the broad ligament unoccupied by the Fallopian tube. It is a structure of great importance, since it forms the outer border of the ovarian pedicle. It is easily recognised, on account of the pampiniform plexus of veins, which is conspicuous even in the normal condition. In ovarian cystic disease this ligament becomes hypertrophied, and appears as a conspicuous fold running from the brim of the pelvis on to the pedicle.

The layers of the broad ligament are closely applied between the tube and the ovary. Below the level of the ovary the layers separate, and pass to the sides of the pelvis. The pelvic connective tissue fills the space formed by the parting of the layers. This tissue can be felt as a tense band, running from the uterus to the side of the pelvis, on digital exploration of the vagina.

When the rectum is explored, the back of the broad ligament can be reached. This is impossible in vaginal examination.

The layers of the broad ligament are often separated by tumours, which push in between them, either from the direction of the ovary or from the uterus, as in fibroid tumours. In the

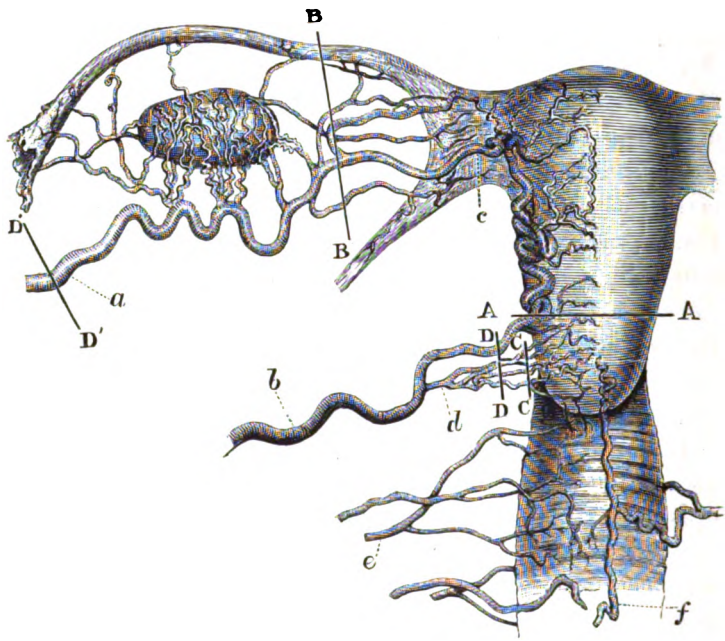


FIG. 117.—THE ARTERIES OF THE INTERNAL FEMALE ORGANS. (*Modified from Hyrtl.*)

a, Ovarian artery; *b*, Uterine artery; *c*, Anastomosis of ovarian and uterine arteries; *d*, Artery to the cervix; *e*, Vaginal arteries; *f*, Azygos artery of vagina; A A, Line of amputation in supravaginal hysterectomy; B B and D D, Vessels secured in hysterectomy; B B and D' D', Vessels secured in ovariotomy; C C, Vessels divided in freeing the cervix.

former case there will be difficulty in making a good pedicle; in the latter oöphorectomy may be dangerous, as the broad ligament no longer forms a sheet-like structure, but often becomes a pyramidal body, with its base towards the uterus, highly unsuited for the safe application of the ligature.

The ovarian artery (Fig. 117) enters the broad ligament from the pelvic brim, and becomes very tortuous when it reaches the infundibulo-pelvic ligament; and this tortuousness increases as

it passes between the layers of the broad ligament, below the level of the ovary, upwards and inwards to the upper part of the body of the uterus. Before reaching the uterus it divides into two branches; the upper supplies the fundus, the lower anastomoses with the uterine artery, which passes vertically upwards to meet it. The branches of this artery are numerous. Several small vessels run to the dilated outer end of the Fallopian tube, supplying the fimbriæ. Half-a-dozen short, tortuous branches of wide calibre supply the ovary itself, entering that organ through

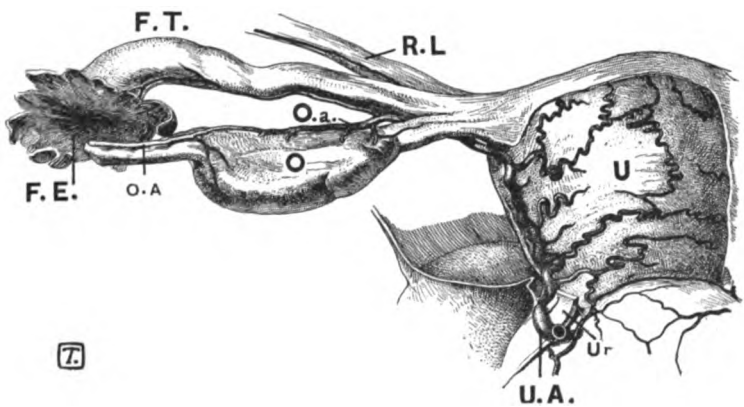


FIG. 118.—THE STRUCTURES IN THE BROAD LIGAMENT AND THEIR ARTERIES. (*After Testut.*)

U, Uterus; O, Ovary; F.T., Fallopian tube; R.L., Round ligament; F.E., Fimbriated extremity of the tube; O.a., Ovarian artery; U.A., Uterine artery; Ur, Ureter.

the hilum. Two or three branches run across the broad ligament to the inner two-thirds of the Fallopian tube, and the round ligament receives a special branch.

In ovariotomy and allied operations on the uterine appendages the ovarian artery is divided in two places. It must be cut through at the outer border of the pedicle, where it lies in the infundibulo-pelvic ligament, and also at the point where it crosses the line of ligature of the pedicle—that is, in the middle of its course towards the uterus, between the layers of the broad ligament. Hence a complete segment of the artery is cut away, and is easily detected on examining the tumour after operation.

The liberal supply of arteries to the broad ligament, and the shortness of secondary branches, account for the free hæmorrhage which occurs when the ligament is wounded or split in an operation on the internal organs, especially through faulty tying of the ligature. It is evident that the main trunk of the ovarian artery will bleed as much from its distal as from its proximal end, if not secured. The ligature applied to the outer border of the pedicle secures the ovarian artery as it lies in the infundibulo-pelvic ligament. The ligature which secures the inner half of the pedicle will, or should, hold firm the distal part of the ovarian artery, which communicates freely with the uterine. The division of the ovarian artery into two large branches, between the layers of the broad ligament, close to the uterus, is a source of peril when the pedicle of an ovarian tumour is very short.

The ovarian vein has the same general course as the ovarian artery. It forms near the ovary a plexus—the pampiniform plexus—which lies in the broad ligament, and communicates freely with the uterine veins. The ovarian artery can be felt, or even seen, pulsating amidst the turgid mass of veins. The plexus is surrounded by much loose connective tissue, which may inflame, and even suppurate if damaged by careless handling in abdominal operations. The bulb of the ovary is a venous plexus surrounding the hilum, and extending to the ovarian ligament. It communicates with the pampiniform and uterine plexuses. It is very plainly seen in cases of oöphorectomy, when the ligature is tightened above a diseased ovary.

Preparation of the Patient.—This matter, together with the question of the position of the patient on the operation table, and the general disposition of the assistants, etc., has already been dealt with (pp. 24 and 93).

Instruments Required.—The following special instruments are required, in addition to those already enumerated as needed for the operation of abdominal section (p. 94):—

Ovariotomy trocar and cannula with tubing, Nélaton's

volsella (two pairs), plain volsella, pedicle needle, simple trocar.

The ovariotomy trocar most generally used is that known as Sir Spencer Wells' syphon trocar (Fig. 119). The instrument is simple, and is admirably suited to its purpose. Its mechanism should be well understood before it is employed, and the surgeon should practise the movements necessary to withdraw and protrude the cannula. The spring hooks at the

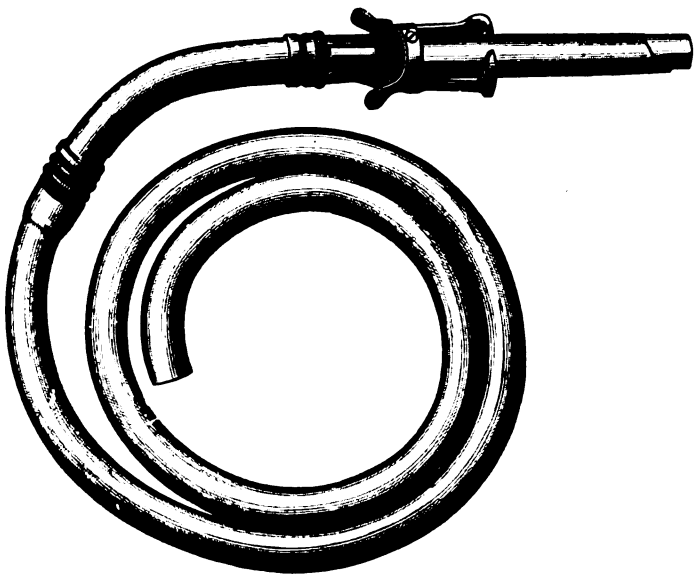


FIG. 119.—SPENCER WELLS' OVARIOTOMY TROCAR.

side of the trocar are for the purpose of holding the margins of the hole in the cyst against the instrument. It should be borne in mind that these hooks have seldom so firm a hold as to allow unusual traction to be exercised upon the whole mass of the tumour. The gutta-percha tube at the end of the instrument should be not less than three feet in length.

Nélaton's volsella is a powerful instrument, used for grasping and holding the cyst when required. It should measure about nine inches in length, and must be strongly made (Fig. 120).

Pedicle Needle.—A pedicle needle is not always employed, and is not necessary. If one be used, that known as Sir Spencer Wells' blunt-ended needle is the best. The needle is fixed in a stout handle some four inches in length, while the shank is about six to eight inches long. The point is blunt, as are also the sides of the needle near the point. The eye is large and oval. The needle and its handle should be made of one piece of metal.

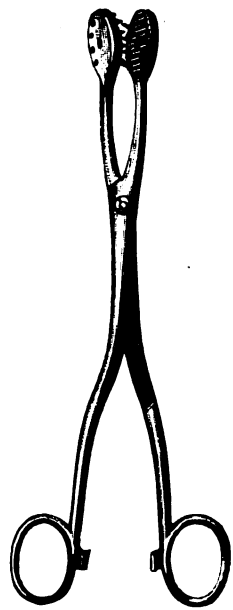


FIG. 120.—NÉLATON'S CYST FORCEPS.

Two or three aneurysm needles of different sizes and curves should also be at hand.

Plain volsella forceps are occasionally useful in grasping the cyst-wall, and also in picking up extensive bleeding points, as after the division of large adhesions, or the slipping of a ligature which has been applied to the same. A common trocar and cannula may be needed for the purpose of tapping secondary or deeply placed cysts.

THE OPERATION

1. **The Incision.**—The abdomen is opened after the manner already described. The incision should be of such a length as to enable the surgeon to extract the tumour with ease. About three inches is the average length of the skin incision when first made. It may be commenced about three inches below the umbilicus.

2. **Exposure and Examination of the Cyst.**—The cyst is exposed, and is recognised by its white shining surface when free. Occasionally the peritoneum is found to be much thickened, or to be adherent to the cyst-wall (p. 436). In attempting to demonstrate the cyst under the latter condition, it should be remembered that to cut prematurely into the cyst is less serious than to strip the peritoneum from the parietes, under the impression that it is the wall of the cyst.

If any ascitic fluid be discovered, it should be allowed to escape, and should be pressed out of the flanks by the assistant. As soon as the peritoneal cavity is opened, a ruptured ovarian cyst may be discovered. The effused matter can be best got rid of by irrigation with warm sterilised water, at blood-heat, and continuing the washing until the fluid flows out clear.

At the earliest possible opportunity the position and state of the uterus should be made out.

The possibility of pregnancy in cases of supposed ovarian disease should never be lost sight of.

It is possible also that the reputed ovarian tumour may be uterine.

"Uterine fibroids are of a pale brick-red colour, owing to the presence of plain muscular fibres and considerable vascularity. Sometimes the surface of a fibroid is very pale indeed, so as closely to resemble that of an ovarian cyst; and if the fibroid be cystic, there will be some difficulty in diagnosis at this stage. A fibroid bleeds violently, even if only slightly cut with the scalpel. In many ovarian or broad ligament tumours which have become invested anteriorly by a layer of the broad ligament, the surface also appears reddish in tint. The presence of the tube, stretched and elongated over the wall of the tumour, also indicates a tumour of this class, and may presage an easy operation, or else imply that some deeper complication exists; for tumours which burrow into the folds of the broad ligament often have very troublesome pelvic connections. The tube and broad ligament may happen to lie on the front of an ordinary multilocular cyst; in this case the exposed surface appears like a veil of thin red membrane covering deeper structures, and very vascular. The tube, generally below, can be recognised. On pushing this membrane aside, the characteristic surface of the cyst-wall will be exposed. When uncertainty exists about the tumour being of ovarian or uterine origin, further exploration will be necessary, even for bare diagnosis.

"When secondary cysts bulge freely from the surface, the chances are that the tumour is an ordinary multilocular cyst.

When the cyst-wall is smooth and shiny, but greenish-grey and semi-transparent, the tumour probably contains a great quantity of adenomatous growth. Malignant ovarian tumours are usually dull-brown or yellow-coloured; sometimes they may be recognised at once as solid masses of sarcoma; but when they contain large cysts, their diagnosis before tapping is often uncertain, the cyst which presents at the wound possibly bearing no malignant characters. A cyst with a whitish surface, rather dull and not very smooth, is probably an ovarian cyst with a twisted pedicle. A dull-white cystic tumour with orange or ochreous patches is very possibly dermoid" (Doran).

Ovarian cysts with twisted pedicle are, however, rarely white; purple or black is a much more usual colour. They may be on the verge of gangrene, and coated with lymph.

3. **Demonstration of Adhesions.**—Assuming the case to be a straightforward one of ovarian cyst, the tumour should be allowed to project into the wound.

The fingers or hand may be passed round the cyst to ascertain if any adhesions exist, and to estimate their character.

During such examination the lighter forms of adhesion may readily be broken down as the fingers pass gently over the surface of the growth. If firmer adhesions are found to exist, they must be fully demonstrated. Adhesions of all kinds are more readily to be dealt with before the tumour has been emptied by tapping. By attempting to break down adhesions after the cyst has been emptied, a portion of adherent bowel may be torn, the flaccid cyst-wall and the bowel being difficult to distinguish from one another. "When a cyst is adherent," writes Sir Spencer Wells, "it is often extremely difficult to find out the exact limits or boundary between cyst and peritoneum; and rather than make any improper or dangerous separation, it is better to extend the incision upwards and downwards, until some point is reached where the cyst is not adherent."

4. **Examination of the Tumour.**—The cyst should be examined carefully before tapping, and if there is any suspicion

that its contents might be infected or irritating to the peritoneum it should be removed whole.

A "healthy" ovarian cyst has usually a shining grey or bluish grey appearance. A dermoid is usually of a yellowish, more muddy colour, and an inflamed or suppurating cyst is also muddy looking, and frequently covered with lymph. If bleeding has occurred into the cyst it will look congested and bluish. The outer surface of the tumour may be studded with papillomatous growths. In any of these cases, where the tumour does not appear to be a "healthy" simple or adenomatous cyst it should be removed whole, *i.e.* without tapping or rupturing its wall.

5. **Tapping of the Cyst.**—Before actually introducing the trocar, a sponge may be inserted between the cyst-wall and the lower angle of the incision, in order to absorb any fluid which may escape.

The cyst is steadied by the surgeon's left hand while the trocar is driven into its wall. In order to bring the walls well up to the hooks on the trocar, the plain volsella may be used; or the assistant may drag the cyst-wall up within the grasp of the hooks as the tumour becomes more flaccid. The volsella is apt to make holes in the cyst, through which fluid may escape. Traction upon the cyst should never be made through the hooks on the trocar alone. These hooks are more for the purpose of holding the cyst-wall against the cannula. "After the first cavity has been emptied, a second, a third, and more, if necessary, may be tapped successively, without removing the cannula from its hold, merely by pushing the trocar forward and thrusting it through the septum which separates the emptied from the adjacent full cavity. In this manner the whole tumour may be emptied of its fluid contents, and its bulk so reduced that it may be drawn through the abdominal opening without undue force.

"In a case where there are several cysts, which cannot be tapped one through the other, they must be emptied singly, either by the same trocar or by another." (Sir Spencer Wells.) If the cyst be of moderate size or small it may be removed entire

without tapping. This implies a larger abdominal incision, but the tumour remains firm and distinct, and readily handled. We are disposed to avoid tapping whenever feasible in dealing with any but large cysts.

Some tumours which on naked-eye examination appear to be adenomatous, and therefore innocent, are proved by microscopical examination to be carcinomatous. If such a cyst is tapped there is a danger of carcinoma cells being implanted on the peritoneum or on the raw surface of the abdominal wound.

6. **Removal of the Cyst.**—As soon as the part of the cyst that has been pierced by the trocar is well free of the abdominal cavity, the cyst-wall may be grasped by two Nélaton's volsellæ, and traction upon the main body of the tumour made by means of these instruments. At this time also the sponge introduced at the lower angle of the incision may be removed.

As the cyst is drawn outside the abdomen, the chief assistant follows it, as it were, from above.

By means of two large sponges—one held in each hand—he keeps the edges of the upper part of the wound together, exercises gentle pressure upon the escaping cyst, and prevents the protrusion of any coil of intestine or of the omentum. If the tumour be still of large size, any remaining secondary cysts may be tapped with a common trocar, or the supporting septa may be broken down with the fingers. When the secondary cysts are small and numerous, and the mass feels semi-solid, or when abundant glandular growths exist, the substance of the tumour may be broken up by the hand. To effect this the trocar puncture must be enlarged, and, the edges of the opening having been grasped by Nélaton's volsella, the hand can be introduced. Care must be taken that the forceps are so held that none of the broken-down contents can find their way into the abdominal cavity.

In manipulating the cyst, and especially when freeing it from adhesions, it is possible to tear the cyst-wall and to allow the cyst contents to escape into the peritoneal cavity. The accident is not a serious one, as the fluid is nearly always quite

sterile. If the rent be small, it may be closed by being grasped with large pressure forceps; if large, an attempt should be made to bring the opening without the abdominal wound, and, by means of wedging sponges around the tear, to conduct the escaping fluid out of the belly.

In this way the injured cyst may be entirely emptied, and little of the fluid have found its way into the serous cavity.

In the case of more solid tumours the abdominal incision must be enlarged. It is much less serious to increase the size of the wound than to run the risk of rupturing the tumour by endeavouring to drag it through too small an opening. In these cases there is no virtue in a small incision. The escape of solid tumours is much assisted by judicious lateral pressure upon the abdomen, exercised by the hands of the assistants.

7. **Treatment of Adhesions.**—This subject has already been dealt with (p. 102).

8. **Treatment of the Pedicle.**—The cyst having been drawn without the abdomen, nothing remains but to deal with the pedicle, which, in an uncomplicated case, now occupies the lower angle of the incision. In the majority of cases the pedicle is long, free, and tolerably broad. It is easily recognised by the Fallopian tube, which marks its upper or inner border.

"The ordinary pedicle will consist of a plane surface, two or three inches wide, and about the same length, representing the tube, the broad ligament, the ovarian ligament, which may or may not be readily detected, and, lastly, an elevated ridge running from the back and outer part of the plane, upwards, outwards, and backwards, towards the lumbar region.

"This ridge, which forms the outer border of the pedicle, is filled with the large veins forming the pampiniform plexus and the ovarian artery" (Doran). (Fig. 121.)

The pedicle is secured by ligatures. The best material for the ligature is silk. Many surgeons use and strongly recommend kangaroo tendon. If silk be used it should be no thicker than is consistent with sufficient strength not to break in tying the knots.

In dealing with the pedicle, a rule should be observed which should apply to every abdominal operation—*a ligature should never be so applied as to include undivided peritoneum.* Exceptions to this important rule are very few, and are represented by such measures as the ligaturing of omentum and the securing of certain adhesions.

Before any ligature is applied, the peritoneum should be divided. The procedure is well illustrated by the treatment of

FIG. 121.—PEDICLE OF AN OVARIAN CYST.

The cyst has been tapped. The vessels in the outer border of the pedicle are indicated (semi-diagrammatic). (*Doran.*)

the ovarian pedicle. The pedicle is as well displayed as is possible, and then, with a small scalpel, the serous membrane is divided completely on both sides of the pedicle in the line the ligature will follow. The subserous connective tissue in the pedicle is thus displayed, and gaps in the membrane are made evident, or are capable of being made evident. By enlarging these gaps the individual factors of the pedicle are isolated, the pedicle is reduced in bulk, and the separate parts are ligatured cleanly and precisely. A pedicle needle is not needed, as the ligatures are passed through the gaps made. We use three ligatures, one for the Fallopian tube, one for the ovarian ligament and tissues about it, and one for the pampiniform plexus and artery. These ligatures will not slip, whereas ligatures which embrace

undivided peritoneum will often slip. The division of the peritoneum, moreover, undoubtedly saves much after-pain. This procedure will be found to be especially satisfactory in cases of left-sided tumours with broad pedicles where the pedicle blends with the meso-sigmoid. Ligature *en masse* in this situation may result in the formation of a hæmatoma close to the sigmoid, due to puncture or incomplete ligation of a vein, which is difficult to deal with.

The knot tied should be a double reef or surgeon's knot, and the threads should be drawn as tightly as possible.

It is important, as the ligatures are tightened, that the assistant should relax his traction, so that there is no tension of the pedicle.

The exact point at which the pedicle is transfixed must be determined by common surgical sense. The ligatures should not be placed quite close to the uterus on the one hand, nor too near the cyst on the other.

The threads must be cut short and the pedicle divided with scissors three-quarters of an inch beyond the line of the ligatures.

Before the stump of the pedicle is dropped back into the pelvis, forceps may be attached to either margin of it, so that at any time before the completion of the operation the divided surface may be drawn up for inspection.

There is nothing to commend the practice of clamping the pedicle before the ligatures are applied.

In examples of very broad pedicle the tissues may have to be ligatured in more than three sections.

A great deal has been written about the securing of the pedicle by ligature, and especially about the danger of splitting the pedicle. This accident is supposed to happen when the pedicle is secured by transfixion with the pedicle needle. We have never met with this trouble, and do not consider it possible if ordinary care is exercised.

In certain advised methods of securing the pedicle much ligature silk is employed, and is left *in situ*. This would appear

to be undesirable. Probably the greatest safety is secured by the smallest, simplest, and neatest knot, and by the least possible disturbance of the ligatured area.

Abnormal Pedicles.—(1) The pedicle may be found to be short and broad, and the base of the tumour to be close to the side of the uterus. In such case there is no great difficulty in ultimately obtaining a practicable pedicle.

The peritoneum on all sides of the pedicle must be divided, and the component parts made evident. The vessels thus well isolated are secured, and then the tube and any remaining tissue.

(2) In other cases the pedicle is obscured by pelvic adhesions. These must be secured and divided one by one, or area by area, until a pedicle can be demonstrated. Mr. Doran points out that an atrophied second pedicle, in cases where the tumour consists of two cystic ovaries fused together, may be taken for an adhesion. When the pelvic adhesions are very short, broad, and tough, and a practicable pedicle exists, it is better to secure the pedicle first and deal with the adhesions later. In all instances a free division of peritoneum will be of great assistance.

(3) The pedicle may have been twisted, and consequently reduced to a mere cord almost devoid of blood-vessels, the cyst deriving its blood supply from adhesions, mostly from adherent omentum. This is very exceptional. In the more usual cases of recently twisted pedicle the ovarian tumour should be rotated in the opposite direction of the twist until the latter is done away with. The pedicle is then displayed and ligatured in the manner already described.

(4) There may be no pedicle at all. In such a case the original pedicle has been twisted, has atrophied and disappeared, the tumour receiving its sole blood supply through adhesions, such adhesions being very commonly with the omentum, as already stated. These adhesions are isolated and ligatured in strands or segments.

9. **Completion of the Operation.**—All bleeding having been arrested, the opposite ovary may be reached by passing the fingers along the uterus, and may be drawn up and examined.

The pelvis is now well sponged out. The stump of the pedicle should be drawn up by means of the forceps still attached to it, and, it having been examined, the instruments may be removed. Sponges should be counted, and the greatest care taken that no sponge or instrument has been left within the abdominal cavity.

No drainage will be required. Nothing now remains but to close the abdominal wound after the method described in the previous chapter.

10. **The after-treatment** has already been detailed. The period for recovery in an ordinary case may be reckoned at one month. Some surgeons allow their patients to get up at an earlier period than that named in the section on after-treatment (p. 123). As a rule, a confinement to bed of three to four weeks is usually advisable.

TREATMENT OF ENCAPSULED OVARIAN CYSTS

On exposing or on tapping an ovarian cyst, it may be found that the cyst-wall is invested in front by a capsule, generally of a very pale red colour, and contrasting strongly with the white cyst-wall behind it. The capsule is formed by the distended layers of the broad ligament into which the tumour has forced itself, and by peritoneum detached from adjacent parts of the pelvis. In extreme cases the inferior part of the cyst may lie below its serous capsule, touching the pelvic fascia, and in close proximity to large vessels, the ureters, and the adjacent viscera.

In such a case the capsule should be divided, and the cyst shelled out of its bed in the subserous connective tissue. The ovarian vessels should be laid bare as they approach the pelvic brim, and should be well exposed and, when isolated, ligatured. The tube is in like manner isolated and ligatured before division. The ovarian vessels may be spread over the cyst, but they will be found to come together at the pelvic brim. Never ligature large and vague masses of tissue. Divide the peritoneum, isolate the structures exposed, and cleanly ligature all those which need division.

The gap left in the capsule by the removal of the cyst may be closed by a few fine sutures. No drainage of any kind is needed.

RESULTS OF OVARIOTOMY

The mortality of ovariotomy has been steadily reduced year by year since the operation was first introduced.

At the early periods of its development the death-rate was very high—so high that the procedure was condemned as unjustifiable by many. Up to 1876 Sir Spencer Wells had performed ovariotomy seven hundred and thirty-seven times, with a mortality on the whole series of about 26 per cent.

Sir Spencer Wells' analysis of one thousand cases of ovariotomy, published in the *Med.-Chir. Trans.* for 1881, is a contribution of great interest and of historical value.

The mortality is now represented by 2 to 3 per cent., or even less. Several operators, including Dr. A. H. N. Lewers, have recorded a hundred consecutive cases without a death.

The conditions which influence the mortality of the operation are the same as those which affect the death-rate after other operations.

The special complication of *pregnancy*, however, requires a word of notice. Ovariotomy has been performed with perfect success during all periods of pregnancy.

Ovariotomy has been performed with success *during labour* by many operators.

In some cases the patient has reached the full term, and has been delivered without complication of a living child. In other instances abortion has followed the operation at periods varying from a few hours to several days. Abortion directly due to ovariotomy has, according to Olshausen, occurred in less than 20 per cent. of all the recorded cases.

CHAPTER XVI

REMOVAL OF THE UTERINE APPENDAGES

THIS operation, which is also known by the name of oöphorectomy, has been carried out under the following varied conditions :—

1. To remove diseased uterine appendages. Under this heading are included chronic and subacute inflammation of the ovary, abscess of the ovary, hernia of that body, Fallopian pregnancy, and the various inflammatory and other affections of the Fallopian tubes.

2. To induce a premature menopause, in order to check hæmorrhage from the uterus, such as may be associated with uterine myoma. Oöphorectomy with this object has very properly fallen into disuse.

3. To check the progress of mammary cancer, especially when it has recurred after excision of the breast in too extensive a form to justify further attempts at removal. This operation is still in the position of a purely speculative measure.

The removal of the uterine appendages in cases where the structures are anatomically normal, or practically so, is an exceedingly simple procedure.

When, however, the appendages are diseased, the surgeon who proposes to remove them embarks upon an enterprise the precise course and ending of which he cannot foretell. Some of these operations are difficult and complicated, and present a very uncertain and intricate series of conditions.

In not a few cases it has been found to be impossible to complete the intended excision.

Every case must be considered upon its merits, and the surgeon must have clear notions as to the amount he intends

to remove in various circumstances. In the majority of instances the parts excised will be represented by the ovary, the parovarium, the outer three-fourths of the Fallopian tube, together with the corresponding part of the ovarian artery, the pampiniform plexus, and the broad ligament.

The operation will be described as it would be carried out in a case in which the parts are practically normal. The treatment of the various complications which arise when the parts are not normal will be considered subsequently.

Instruments Required.—The same as for ovariotomy, with the exception of the trocar, the volsella, and the cyst forceps.

The Operation.—The patient having been prepared for abdominal section, a vertical incision about two inches in length is made over the linea alba below the umbilicus. The centre of the cut will be nearer to the symphysis than to the umbilicus.

The cavity of the peritoneum is opened in the manner already described. The intestines and great omentum will be largely prevented from getting in the operator's way if the patient has been placed in Trendelenburg's position—*i.e.* with the pelvis raised above the level of the thorax (*see*, however, p. 101).

All bleeding having been checked, two fingers are introduced into the wound, and the fundus uteri is sought for. The fingers embrace the broad ligament as if they were the blades of very long dressing forceps, and are carried outwards—one on each side of the tube—until they are arrested by the ovary.

The ovary is now drawn out of the abdomen by the two fingers, which retain the same forceps-blade attitude. It is then handed over to an assistant, who holds it well away from the abdominal wall. The surgeon displays the pedicle, carefully and completely divides the peritoneum with a fine knife, and ligatures the structures exposed in the manner already described (p. 439). Three silk ligatures are employed, one for the tube, one for the vessels, and one for the ovarian ligaments and remaining structures.

It often happens, even when no adhesions exist, that there is some difficulty in dragging the ovary well out of the wound.

This is notably so when there is a thick layer of fat upon the abdominal parietes. In such cases much strain falls upon the broad ligament, and the surgeon's fingers alone are not sufficient to hold the parts in place. In these instances it is necessary that the appendages should be seized by large-elbowed pressure forceps.

The pedicle in this operation is secured in precisely the same way as in ovariotomy (p. 439). Silk of medium thickness is commonly used, but kangaroo tendon answers admirably.

The parts are cut away close to the retaining fingers or the retaining forceps, and at least a third of an inch from the ligature.

Before the division is made, it is well to fix one or possibly two pairs of artery forceps upon that part of the pedicle which lies between the ligature and the intended line of section. When the division is made, the forceps—which inflict no damage upon the part—prevent the stump from falling at once back into the pelvis, and allow it to be examined at leisure, and to be drawn forth should further ligature be needed.

The wound is closed, and is dressed in the usual way.

Throughout the operation the anæsthetic must be carefully administered. Should the abdominal muscles undergo sudden contraction (as from coughing) when the ovary is without the wound, and when the pedicle is about to be dealt with, the appendages may slip back into the abdomen again if lightly held, or be needlessly dragged upon if rigidly grasped.

Treatment of Adherent Appendages.—The omentum may be adherent to the appendages, and may at the same time also be attached to other parts of the surface of the peritoneum. As a result of these adhesions the anatomy of the part may be greatly confused, and a condition be induced which is at first peculiarly puzzling. In other instances the appendages may be bound down by adhesions, or be lost in a confused mass of cicatricial tissue. It may be impossible to identify the ovary by the touch. The surgeon may be quite unable to demonstrate any kind of pedicle. The structures to be removed may be adherent to the bowel, or to the bladder, or to the peritoneum lining the floor of the pelvis. They may be the seat of abscess or of some variety

of cystic formation, and the removal of the diseased parts without rupturing the abscess-wall may be attended with the greatest difficulty.

Each case must be considered on its merits. Omental adhesions can be dealt with with comparative ease, but the adhesions which fix the appendages may defy the most patient and most skilful operator. Until the adhesions have been dealt with it will be impossible to bring the appendages into view or into such a position as will enable the operator to apply the necessary ligature.

In such cases the wound must be enlarged; and by means of suitable retractors and a good light, aided by efficient sponging, the parts to be removed must be exposed, and the adhesions dealt with as the particular case requires. The Trendelenburg position and an electric hand-lamp will be found most useful.

There is little to commend the practice of attempting to effect the separation of the appendages with the fingers only, working through a small incision. Skilful fingers might effect much—and in few operations is a highly educated touch of greater value—but there is nothing in this procedure to justify a direct departure from the sound principle that the surgeon should, whenever possible, be able to see what he is doing, and that manipulations in the dark are not worthy of encouragement. Of the two evils—a large incised wound in the median line of the abdomen, and the risk of tearing structures while breaking down adhesions which are hidden from view—the former is without doubt the lesser. In some of these cases the bleeding is described as being occasionally "truly alarming." If there be a risk of "alarming" bleeding from wounds and lacerations in the depths of the pelvis, let the external wound be large enough to allow the surgeon to deal with that hæmorrhage in a straightforward manner.

The small incision in these cases involves a procedure which is unsafe and difficult, unsound and clumsy. It can appeal only to those who aim at a certain theatrical effect, and who test the greatness of an operator by the littleness of his incisions.

CHAPTER XVII

HYSTERECTOMY

HYSTERECTOMY, or removal of the uterus, is carried out for myoma, for incurable inversion, and for malignant disease.

For uterine myoma (fibroid tumour) complete hysterectomy (by an abdominal incision) is now advocated. Now and again the cervix uteri is left behind (supravaginal amputation), and in the case of small myomata vaginal hysterectomy is occasionally performed. For incurable inversion the removal may be partial or complete. In dealing with malignant disease the removal should be complete, and if an attempt is to be made to remove the lymphatic glands the abdominal route must be adopted of necessity. The immediate mortality of this operation is, however, considerably higher than that of vaginal hysterectomy.

History of the Operation.—Granville, in 1827, is reported to have removed a uterine myoma, but without success. A few isolated instances of the operation are recorded in succeeding years, but none of the patients recovered. The first successful operations were performed by two American surgeons—Burnham in 1853, and Kimball in 1855. In 1861 Sir Spencer Wells performed his first hysterectomy for myoma. Mr. Keith's first case was in 1874. The development of the operation owes much to the successful and brilliant operations of Keith, who may be said to have first turned the tide in the direction of success. The literature of the subject is most voluminous. In Kelly's work on Operative Gynæcology will be found the best illustrated discussion of the subject.

The first successful vaginal hysterectomy for cancer is ascribed to Sauter of Constance, who operated in 1822.

For many years the cases operated on were very few, and the mortality was very high. The operation was revived by Czerny in

1879, and was rapidly developed by Billroth, Schroeder, Mickulicz, and others.

Freund carried out the abdominal method of operating in these cases, and his procedure was extensively imitated. The results, however, were much more serious than those following vaginal hysterectomy. Even now, with much improved methods, abdominal hysterectomy for cancer is attended with greater risk than the vaginal operation, although it may be a more radical and efficient procedure.

Anatomical Points.—The peritoneum which covers the uterus is closely adherent to the fundus, but is less firmly attached to the lower part of the organ, where it is reflected to form the utero-vesical and utero-rectal pouches. The reflexion of the peritoneum from the uterus to the bladder is about the level of the internal os. On the posterior part of the uterus the serous membrane descends for nearly an inch over the posterior vaginal wall before it is reflected on to the rectum.

The median utero-vesical pouch is separated from the para-vesical pouch on either side by two slightly marked folds, wherein are slight bands of unstriped muscle. Below these, and embedded in the subjacent veins, are the ureters. When the bladder is empty, and the uterus normal in position and size, a distance of nearly half an inch will separate the cervix from the point of entrance of the ureter into the bladder.

The lower third of the cervix projects into the cavity of the vagina; the middle third is connected with the base of the bladder in front, but projects behind into the vagina; the upper third is supravaginal, and is in direct relation with the bladder in front, but is covered by the peritoneum behind. The peritoneum can readily be detached from the posterior part of the vagina and cervix.

The ureter on entering the pelvis crosses the bifurcation of the common iliac arteries, and makes its way towards the cervix uteri. The uterine artery crosses it upon its inner side (*see* Fig. 118). The ureter will run parallel with the cervix, and at a distance of nearly half an inch from it, and will pass through the plexus of uterine veins, and beneath the broad ligament.

Keeping close to the vagina, it enters the interval between the vagina and the bladder, and opens into the latter viscus about opposite to the middle of the anterior vaginal wall.

The ovarian artery and vein have been already described (pp. 430–432). The uterine artery is, under normal conditions, no larger than the posterior auricular, but in the conditions

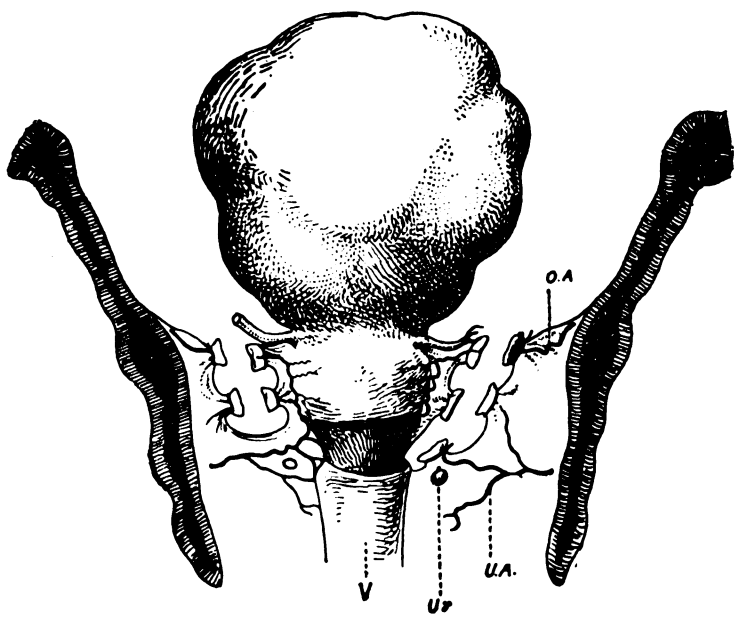


FIG. 122.—DIAGRAM OF COMPLETE HYSTERECTOMY FOR FIBROID TUMOUR. (From paper on Pan-Hysterectomy by Dr. Christopher Martin, of Birmingham.)

The figure illustrates the successive ligature of portions of the broad ligament and contained vessels. On the right side the uterine artery has been secured, on both the ovarian vessels.

V, Vagina; Ur., Ureter; U.A., Uterine artery; O.A., Ovarian artery.

requiring hysterectomy it is usually several times as large. In its course forwards it keeps near to the floor of the pelvis, and reaches the uterus at its junction with the vagina. It gives branches to the vagina. It runs upwards on the side of the uterus, between the layers of the broad ligament, and follows an exceedingly tortuous course.

It is crossed by the ureter about the level of the external

os. It supplies the uterus by many branches, and ends superiorly by joining with a branch of the ovarian artery (Fig. 117).

The uterine veins form an extensive plexus—the greater part of the blood from which is returned by the ovarian vein. The uterine lymphatics mainly end in a group of glands placed on either side along the internal iliac vessels and the bifurcation of the common iliac arteries. A few accompany the ovarian vessels to end in the lumbar glands surrounding the aorta.

The following operations will be described :—

1. Complete hysterectomy for myomata by the abdominal method.
2. Complete hysterectomy for cancer by the abdominal method.
3. Vaginal hysterectomy for cancer.

In the second edition of this work the extraperitoneal treatment of the cervical stump was described in full. This method involved the use of a wire serre-nœud, and, although attended with some success, it has been generally abandoned. Supravaginal hysterectomy is still performed, and involves little risk of damaging the ureters, but the following objections to it have been urged : There may be persistent oozing from the stump. The latter may become infected, or may even slough. Owing to the extensive peritoneal seam, etc., intestinal adhesions and obstruction may develop.

It should be noted that if hysterectomy is being done for a tumour of the body of the uterus, there is some risk as regards recurrence of the growth in the uterine stump. In many cases it is impossible to be certain that the tumour is not a sarcoma or carcinoma until it has been examined microscopically.

On the other hand, if the cervix be removed, especial care has to be taken to avoid damaging the ureters.

I.—COMPLETE HYSTERECTOMY FOR MYOMATA BY THE ABDOMINAL METHOD

For fibroid tumours this operation is said to have been first performed by Bardenheuer. Although for some time oöphorec-

tomy was practised as a substitute for the operation, it has been generally abandoned for the following reasons: It is quite as difficult to perform (in cases of large myoma of the uterus) as hysterectomy; its mortality is as high or higher; the convalescence is longer and attended with more pain; above all, the results of oöphorectomy are most uncertain. It has frequently happened that hysterectomy has after all had to be performed.

The chief indications for hysterectomy for fibroids (myomata) of the uterus are:—

1. Repeated hæmorrhage, leading to anæmia and increasing loss of strength.

2. Interference with the normal visceral functions by pressure of the tumour.

3. Mere bulk of the tumour causing an invalid condition.

4. The supervention of certain complications is to be feared —such as malignant degeneration of the growth, pyo-salpinx, hydro-salpinx, ovarian cyst.

As Furneaux Jordan points out (*Brit. Med. Journ.*, Jan. 26th, 1907), it would appear that over 40 per cent. of the patients in whom hysterectomy was done for uterine fibroids "would have died from existing complications had no operation been done." This important deduction is based on an analysis of 1,400 cases operated on by various English and American surgeons. The mortality of hysterectomy is almost insignificant compared with the danger of leaving alone a large uterine fibroid. Taking 100 cases of abdominal hysterectomy for this condition operated on by Mr. Furneaux Jordan (seventy-six cases) and Dr. Helme (twenty-four cases), there were only three deaths. Although the general mortality of the operation is probably larger than these very favourable statistics indicate, there can be little doubt that it is the method to be selected in dealing with fibroid tumours which are causing symptoms grave enough to justify operation.

Preparation of the Patient.—The bowels must be thoroughly cleared and the bladder empty when the patient is brought to the theatre. The pubes should have been shaved, and the skin

disinfected in the usual way, the vagina washed out with a solution of lysol or bichloride of mercury.

Instruments.—These are very much the same as those required for ovariotomy. Long curved scissors, pedicle and various aneurysm needles, volsella forceps, and several clamp forceps (large Wells pattern) will be required. For ligaturing the arteries and for the buried sutures most operators prefer sterilised silk, but care should be taken in its selection—*i.e.* it should be strong enough to stand any ordinary strain, but at the same time not needlessly thick. Catgut or kangaroo tendon may replace it to a large extent, but in tying the uterine arteries silk is the safest, as it is the least likely to slip.

The Operation.—Surgeons differ as to the most convenient position for the patient. Some strongly advocate the Trendelenburg posture. Others have the pelvis slightly elevated, and prefer this to the extreme inclination of the abdomen and thorax involved in the former position. Whichever be adopted, the operating table must be placed so that a strong light falls on the wound, and, if practicable, a portable electric lamp should be at hand. The patient's limbs and chest must be kept enveloped in warm blankets throughout the operation; and, if the heart's action flags owing to hæmorrhage, immediate recourse must be had to injections of strychnia and transfusion of sterile saline solution.

(1) The abdomen is opened in the median line, and the tumour is exposed. Any adhesions encountered are dealt with. Provided that the case admit of it, the growth is delivered, is drawn out of the abdomen, and is lifted vertically upwards by one or more assistants.

Great care must be taken in separating adhesions of intestine or of the bladder. Those of the great omentum give little trouble, as multiple ligature of its vessels by means of an aneurysm needle will enable the adherent portion to be cut off and removed with the uterus. Any adherent portion of intestine must be carefully peeled off by blunt dissection; and it may be noted that a fatal result has sometimes followed an over-

looked tear of the rectal wall. It is of the greatest assistance to deliver the fibroid uterus through the wound, and Kelly points out that when the rounded mass cannot be drawn up from the pelvis this may be attained by the assistant's fingers in the vagina pushing the tumour strongly upwards. In some cases the tumour can be drawn up much more easily if the round ligaments are ligatured and divided first. At the same time the traction should not be sufficient to endanger the vessels in the pedicle. In raising the tumour a stout steel corkscrew will be found useful; it is fixed into the thickest part of the mass.

(2) The next step is to secure the arteries which supply the myoma. These vessels are two in number on either side—the ovarian, and the uterine. Their position can be ascertained without difficulty, and they are subject to very little anatomical variation. They are no larger than are the arteries which may have to be dealt with in removing very large tumours from the surface of the body, and the vessels can be reached before the trunks are breaking up into many branches.

The ovarian vessels are defined in the broad ligament, are secured between two sets of ligatures, and divided. The surgeon proceeds to sever the broad ligament—when that structure is still present as a ligament—in a direction which would correspond to a line roughly drawn from the brim of the pelvis to the cervix uteri. It is throughout divided by section of the peritoneum. The veins of the pampiniform plexus are apt to be very voluminous, and may be as large as, or larger than, the thumb. The round ligaments will need to be severed between ligatures, unless they have been previously divided (*see* above). In due course the broad ligament upon either side will have been divided nearly to the uterus, and all the vessels belonging to the ovarian set will have been secured.

The ovaries should not be removed unless they are diseased. In other cases all the structures in the broad ligament and the appendages will be removed with the tumour. The former site of the ligament will be represented by a linear breach in the peritoneum along the floor of the pelvis, marked by many

ligatures. The surgeon should endeavour in this part of the operation to render the broad ligament as flat as is practicable, and to have the tumour so held that it is as little in the way as possible.

(3) Separation of the Bladder.—As the uterus is raised and drawn backwards the peritoneal reflexion from its wall to the bladder is carefully divided from side to side with scalpel and scissors. The cutting should be done towards the cervix and vagina, and need not be extensive, as moderate pressure will

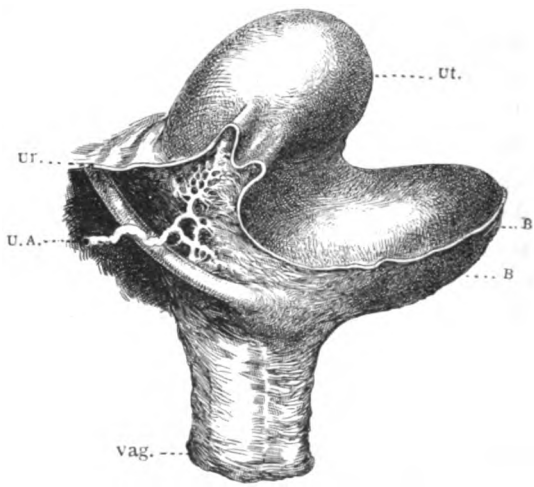


FIG. 123.—DIAGRAM SHOWING NORMAL RELATIONS OF URETER TO UTERINE ARTERY AND THE REFLEXIONS OF PERITONEUM. (From Kelly's "Operative Gynecology.")

Vag., Vagina; B B, Bladder; Ut., Uterus; U.A., Uterine artery; Ur., Ureter.

detach the bladder wall once the interspace is opened. The scalpel should be drawn across the anterior wall of the uterus from side to side, dividing the peritoneum only, above the vesico-uterine pouch. If the incision be made too deep there will be unnecessary bleeding. The bladder and a flap of peritoneum can be detached by the fingers except over a small area in the middle line where it is often necessary to use scissors or scalpel to separate the peritoneum. The flap thus secured is useful in the final suture. The uterine vessels will probably be seen.

(4) The uterine artery on each side has now to be secured

close to the neck of the uterus. Its position has been referred to, and is depicted in Fig. 123. It is best picked up by a large aneurysm needle, which is passed (threaded) close to the cervix, and which is then unthreaded and withdrawn, leaving the ligature in place. In this manœuvre very great care must be taken not to damage the ureter.

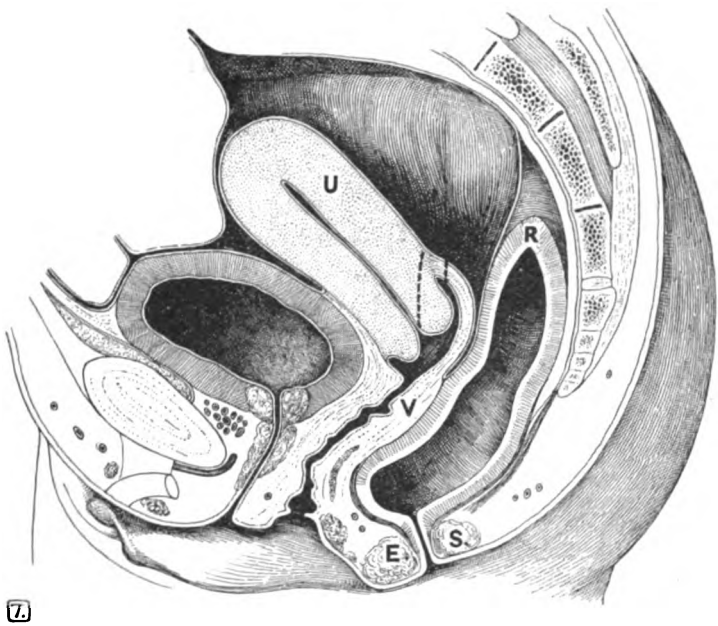


FIG. 124.—SAGITTAL SECTION TO SHOW RELATIONS OF UTERUS TO THE PERITONEUM AND BLADDER, ETC.

Two dotted lines behind and below the uterus indicate the incisions for opening the posterior fornix in complete hysterectomy, and (the longer and anterior one) that for supravaginal hysterectomy. It will be seen that very little of the cervix uteri is left in the latter operation.

U, Uterus; V, Vagina; R, Rectum; E.S., External sphincter.

When these two arteries have been secured, there remains no known vessel to supply the growth.

(5) Either the anterior or posterior fornix is now incised, and the finger introduced into the vagina; with it as a guide the operator works round with curved scissors, taking care to keep close to the cervix. The uterine vessels are cut well

beyond their points of ligature, and the ureters carefully avoided. Kelly advises preliminary catheterisation of the ureters before the operation (as first advocated by Pawlik in 1889), in order to avoid danger to them at this stage; but most operators do not consider it necessary. The important point is to keep the scissors hard on the uterus. In most cases a little blunt dissection with the fingers at each side will push the ureter out of danger.

The tumour is removed, and if either uterine artery is badly secured it must be at once clamped and again tied. Cervical branches given off from the uterine artery at a little distance from the cervix will probably require to be ligatured.

In some cases enucleation of a fibroid situated low down at the side of the uterus will render ligature of the uterine artery more easy.

(6) The operator searches for all bleeding points, removes the sponges or gauze which may have been introduced during the operation, and, when he is thoroughly satisfied that the ligatures are holding well, proceeds to sew up the vaginal roof, and subsequently the peritoneum over it, with a double row of fine silk or stouter catgut sutures (interrupted). Drainage through the vagina is unnecessary.

The usual counting of sponges is gone through, and the abdominal wound thoroughly closed.

After-treatment.—If much blood has been lost and shock is severe, free transfusion with sterile saline solution and injections of strychnia should be employed. Persistent vomiting is best treated with rectal feeding and hypodermic injections of small doses of strychnia and morphia.

Intra-abdominal hæmorrhage may necessitate reopening the abdominal wound and searching for the bleeding vessel. No complication can be more serious than this, and hence the operator should spare no trouble in making sure that all vessels are securely tied before completing the closure of the abdomen. Dr. H. C. Renton records a case of partial hysterectomy in which he was compelled next day to reopen the wound, and to apply the

serre-nœud on account of hæmorrhage from slipped ligatures. The patient, after a most critical time, fortunately recovered. ("Clinical Surgery," p. 32.)

Wound of the ureters and imperfect ligature of vessels are the two chief dangers to be guarded against in performing hysterectomy.

With regard to the other details of after-treatment we would refer to what has been said under the head Abdominal Section,

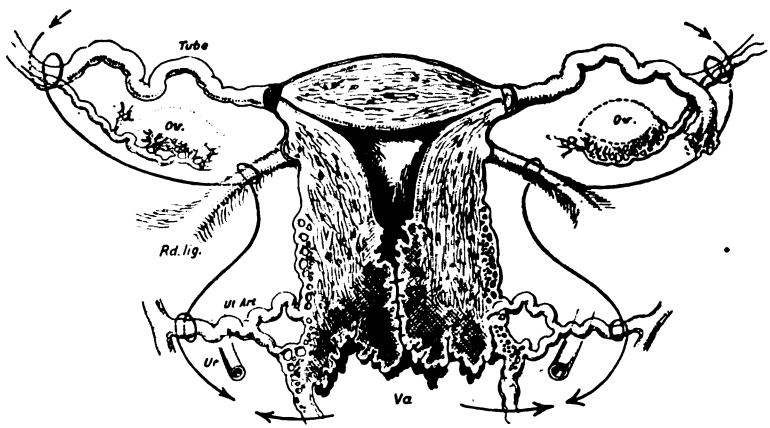


FIG. 125.—PAN-HYSTERECTOMY FOR UTERINE CANCER. (From Kelly's "Operative Gynecology.")

The sinuous line shows the order in which the structures in the broad ligament are divided, commencing with the ovarian vessels, then the round ligament and its vessels, and the uterine arteries. An opening has been made into the vagina posteriorly from Douglas's pouch, and its lateral wall is divided from within as shown by the arrows. Note relation of ureter (Ur.) to uterine vessels.

p. 118. The sutures in the abdominal wound should be left in for ten days or a fortnight.

II.—COMPLETE HYSTERECTOMY FOR CANCER BY THE ABDOMINAL METHOD

In its main outlines this operation resembles that just described; but, whereas the operator will not be troubled by the difficulty of dealing with what is often an enormous tumour, he is far more likely to meet with dangerous adhesions. In fact, the procedure is not justifiable if the vagina is extensively

invaded, and infiltrating adhesions to the bladder, rectum, intestines, or pelvic wall may compel him to abandon the operation.

The danger of obstruction to one or both ureters and of damage to them during the operation is greater in cases of cancer than of myoma. Prof. Kelly, whose summary of the operation is here given, urges that in all cases the ureters should be catheterised. It can be done before the anæsthetic is started by placing the patient on her side and introducing Kelly's straight speculum into the urethra. The atmospheric pressure causes the vesical walls to separate, and the ureteral openings can usually be made out with ease. Fig. 125 illustrates the main steps of the operation, which is described, with slight alterations, in Kelly's words (from "Operative Gynecology," 1898, vol. ii., p. 322).

"(*a*) Catheters are passed into each ureter.

"(*b*) Administration of the anæsthetic, the patient being, of course, supine.

"(*c*) Thorough disinfection of the vagina, which is then filled with a loose iodoform gauze tampon.

"(*d*) Elevation of the pelvis and abdominal incision, exposing the field of operation.

"(*e*) Ligation of the upper parts of both broad ligaments, including the round ligaments.

"(*f*) Detachment of the vesical peritoneum, and of the bladder down to the vaginal vault.

"(*g*) Ligation of the right and left uterine arteries at their origin at the internal iliac arteries.

"(*h*) The dissection and freeing of the uterine arteries with all the adjacent cellular tissue from the pelvic wall in toward the vault of the vagina.

"(*i*) Setting free the ureters, which are lifted up, and away from the field of operation.

"(*j*) Ligation of the large uterine veins above and below the ureter out near the pelvic wall.

"(*k*) Enlarged glands found on the pelvic floor must be taken up with the cellular tissue.

"(*l*) The uterus, with broad wings of connective tissue, is freed down to its vaginal attachment, and the vagina opened at least 2 centimetres below the lowest limit of the disease, anterior to the cervix, with a thermo-cautery.

"(*m*) The opening in the vaginal vault is continued around to the right and to the left, clamping any actively bleeding vessels until the uterus is entirely freed.

"(*n*) As soon as the vagina is incised anteriorly a loose iodoform gauze pack is pushed in, and as soon as the opening is large enough to permit it the lower part of the uterus and the vaginal vault are enveloped in gauze, so as to prevent any discharge from contaminating the wound area; the gauze wrap affords an excellent hold for the operator in making traction upon the uterus as it is gradually delivered.

"(*o*) Bleeding vaginal vessels are controlled by catgut ligatures passed through the vaginal walls, but not including the mucosa.

"(*p*) The entire wound surface is minutely inspected, all oozing vessels controlled by catgut ligatures, and reinforcing ligatures applied to any important vessels where the first ligation seems insecure.

"(*q*) The vesical peritoneum and the peritoneum of the anterior layers of the broad ligaments are drawn back and united by continuous suture to the peritoneum of the posterior layers of the broad ligaments and Douglas's *cul-de-sac*.

"(*r*) If there has been no contamination, the abdomen may be closed at once. If, however, there has been some escape of the uterine contents over the wound and into the peritoneum, the pelvic cavity should be thoroughly washed out after letting the patient down to a horizontal position before closing the abdomen.

"(*s*) The vaginal gauze is changed, and a piece of washed-out iodoform gauze passed loosely up between the lips of the wound to give a little support to the sutured peritoneum above, and to avoid any accumulation of fluids within the wound area."

III.—VAGINAL HYSTERECTOMY FOR CANCER

An admirable review of the position of this operation was given by Sir John Williams in a paper in the *Lancet*, Aug. 23rd, 1890. Since then Dr. A. H. N. Lewers has published several excellent papers on the subject. As we have no personal experience of this operation, we have extracted the following account—a little condensed—from Mr. Doran's well-known work on "Gynæcological Operations" (p. 318).

Instruments Required.—Clover's crutch; Higginson's syringe; Sims's speculum; volsellæ; scalpels; small sponges in holders; two pairs of long-handled scissors curved on the flat; pressure forceps; broad metal retractor; pedicle needle; needle-holder; needles; ligatures; drainage tube.

The Operation.—The patient is placed in lithotomy position, and the lower limbs are separated by a Clover's crutch. The buttocks are brought close to the edge of the table. The surgeon sits facing the perineum. The chief assistant stands on his right, and the chief nurse on his left.

The vagina is washed out with carbolised water. The cancerous ulcer should have been previously plugged with iodoform wool, and the parts made as clean as possible.

A Sims speculum is passed along the posterior vaginal wall. The anterior lip is seized by a volsella, and the uterus is drawn down as far as possible.

1. The assistant now takes charge of the volsella, and pulls the cervix backwards and downwards. The surgeon then cuts through the vaginal mucous membrane along its anterior reflexion on to the cervix by means of the scissors, so that a semicircular wound is made in the anterior fornix, with its convexity forwards.

The hæmorrhage must be kept in check by sponging.

A catheter is passed into the bladder. The anterior part of the uterus is then cut away, with scissors, from its cellular connections with the bladder. The blades of the instrument must be kept close to the uterus. The peritoneum should not be opened at this stage.

The speculum is now removed, and the cervix completely separated from the vaginal mucous membrane. To effect this the cervix is drawn forwards, so as to bring its posterior aspect into view. The mucous membrane along its posterior reflexion on to the cervix is divided with the scissors. This semicircular incision forms, with the one already made in front, a complete ring around the cervix.

2. The cervix being thus detached, Douglas's pouch is now opened up. Care must be taken not to cut too much laterally, lest the broad ligaments be wounded.

At this stage the uterus will remain connected to the surrounding parts by the broad ligaments and the utero-vesical fold of peritoneum. This fold is at once divided.

In order to divide it the operator slips his left fore-finger through the hole in Douglas's pouch, over the fundus and front of the body of the uterus, till the point of the finger presses on the reflexion of peritoneum from the bladder on to the uterus.

The peritoneum is then divided with scalpel or scissors, the operator cutting close to the uterus, and the finger behind the peritoneum serving as a guide. The catheter should remain in the bladder during this stage.

The broad ligaments now alone remain.

3. In order to secure the broad ligaments, the fundus is pulled through the posterior part of the wound with the aid of a strong volsella. This forcible retroflexion is never easy to effect. The right hand should be pressed on the hypogastrium, whilst the left fore-finger is passed through the posterior part of the wound and hooked over the fundus.

When the body of the uterus is pulled down into the wound, the operator must grasp it with the volsella.

The most dangerous stage of the operation is now reached. It is desirable that the ovaries and tubes should, if possible, be removed entire; but this cannot, as a rule, be accomplished.

The surgeon will usually have to satisfy himself with dividing the ligament on the uterine side of the ovary.

The ligament is secured by ligatures, and then cut. The

difficulties of even this step will be at once appreciated. The structures to be transfixed can never be brought well into view, and it is scarcely possible to relax the ligament sufficiently while the loop is being tied.

The usual procedure—that, namely, of dividing the broad ligaments upon the uterine side of the ovary—will now be described.

A pair of large straight-bladed pressure forceps is made to grasp the broad ligament close to the uterus. A strongly curved pedicle needle armed with silk transfixes the broad ligament from behind, externally to the forceps. The ligature is then secured as in ovariotomy. As the ends of the thread are being pulled tight the assistant must remove the large pressure forceps. The ends of the other thread are then tied round the opposite side of the broad ligament.

The broad ligament is now cut through between the ligature and the uterus. The ends of the ligature should be left uncut till the vaginal wound has been attended to later. The uterus is then drawn to the ligatured side, and the opposite broad ligament is secured in the same manner.

When the ovary and the fimbriated end of the Fallopian tube are removed the process will be far more difficult.

The ligature is very hard to apply; the tissues transfixed are upon the stretch, and the possibility of the knot slipping after it has been tied is considerable.

4. The uterus now comes away. Any remaining bleeding points must be secured by ligature.

The vaginal wound may be closed by sutures, which are inserted with a curved needle held in a needle-holder.

Some surgeons leave the vaginal wound open, and trust to packing of the vagina to prevent the prolapse of bowel or omentum through the rent.

Drainage is advisable in most cases. The simplest form of tube is a long glass drainage tube, which is passed about half an inch beyond the vaginal wound. The vagina is then packed with iodoform gauze.

After-treatment.—A thick pad of iodoform wool is laid over the vulva after the vagina has been dressed, and a sponge is placed over the mouth of the drainage tube if that appliance has been employed. The iodoform gauze plugs must be frequently inspected and changed.

When the drainage tube is used the pelvic cavity must be washed out, should the temperature rise high or the discharge from the tube become fœtid. The sutures in the vaginal wound must be removed at the end of a fortnight, a Sims speculum being passed along the posterior wall of the vagina after the patient has been placed on her back, so as to bring the wound well into view.

Comment.—The methods for performing vaginal hysterectomy are very numerous, and have been subjected to endless variation and modification.

The chief distinctive feature of each operation turns upon the method of securing the broad ligaments.

In this, the most difficult and most important step of the operation, every device has been tried which has been carried out for the control of hæmorrhage.

Ligatures have been employed in various ways, the écraseur has been made use of, and the division has been effected by means of the actual cautery. Those who favour mechanical methods in operating employ a clamp; and, in spite of the objections that will naturally be raised against this clumsy method of controlling bleeding, the clamp appears to have been attended with no little success. In this particular operation the clamp is scarcely a more formidable foreign body than a glass drainage pipe.

Readily to control the bleeding, to effect a complete removal, and to take away with the uterus the ovaries and the tubes entire, it appears to us that it would be better to divide and secure the lateral attachments of the uterus through a median abdominal incision, and then to remove the organ through the vagina in the manner already described.

The uterus has been bisected from the os to the fundus, and

has been removed in two segments, after the broad ligament upon either side has been secured.

The bladder and the ureter have been wounded in this operation. It is also stated that an intestinal fistula has been caused by the pressure of a drainage tube.

As will be apparent from what has been already stated, the great danger in the operation is from hæmorrhage.

RESULTS OF HYSTERECTOMY

The general mortality of hysterectomy for myoma, as derived from a series of combined statistics, was given by Mr. Greig Smith as about 30 per cent. On the other hand, Keith's mortality reached the remarkable proportion in most unpromising cases of only 7.9 per cent. The remarkable improvement that has taken place of late years is illustrated by Dr. H. Spencer's and Dr. T. A. Helme's combined report of thirty-eight cases with only one death (October, 1902). Dr. A. H. N. Lewers (1905) records seventy-three cases of hysterectomy for fibroids in the London Hospital with only four deaths (a mortality of 5.6 per cent.).

Vaginal hysterectomy appears to be attended with a mortality of from 5 to 10 per cent. The precise prospect of "cure" of the cancer in these cases has not yet been demonstrated.

It is apparent that in a very large proportion of the cases a comparatively early recurrence takes place, and some operators have formed most gloomy views as to the prognosis. Dr. Lewers, by an admirable series of cases followed up, has shown that a considerable number—nearly 50 per cent.—remain free from recurrence for many years. Very much depends upon selection of cases. It may be said that it is only at an early stage of cancer, when the disease is confined to the uterus, that the operation is worth doing.

CHAPTER XVIII

OPERATIONS FOR RUPTURED PERINEUM

Anatomical Points.—In the great majority of instances the rupture for which an operation is required has occurred during labour. If the laceration extend into the rectum, and involve the sphincter ani, it is termed "complete." If it fall short of the rectal tissues, it is described as "partial." In carrying out the needed operation the surgeon must bear in mind that he has not merely to form a bridge of skin between the vagina and the rectum, but to restore the perineal body. The term

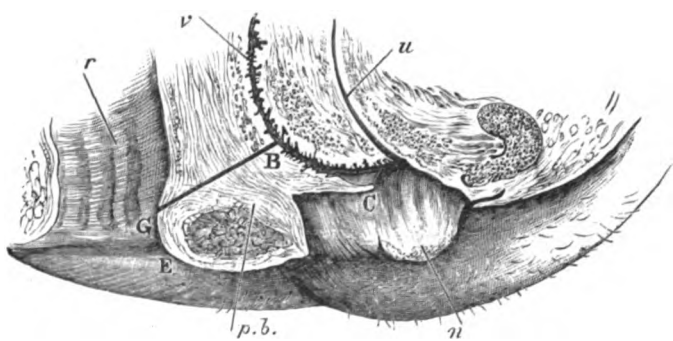


FIG. 126.—SAGITTAL SECTION OF FEMALE PERINEUM. (*Modified from Henle.*)
r, Rectum; *v*, Vagina; *u*, Urethra; *n*, Nympha; *p. b.*, Perineal body.

perineal body has been applied to the pyramidal mass of tough elastic connective tissue which is interposed between the lower ends of the rectum and vagina. It is shown in part in the accompanying figure from Henle (Fig. 126). The base of the pyramid corresponds to the skin extending between the vagina and the anus, which skin represents the anatomical perineum. The apex is at some distance above the orifices of the two canals.

It may be roughly estimated that the perineal body will measure about one inch and a quarter in height, and one inch and a half in breadth. The complete restoration of this important supporting buttress is the main feature in operations for ruptured perineum.

In the anterior part of the base of the perineal body is the central point of the perineum, at which point the sphincter muscles of both the vagina and the anus and the transverse perineal muscles meet.

When some weeks or months have elapsed after the laceration has occurred, and when the parts have well healed over, it is a little difficult at first to realise what has been the full extent of the injury, and what must be the full extent of the restoration. This is especially the case when the parts are patulous, when the mucous membrane is bulging downwards, and when the cicatrix is ill-marked.

The torn surfaces, which should be in contact, and vertically placed, are now widely separated, and are reduced to nearly the same horizontal plane.

Operative Measures.—The treatment of ruptured perineum by operation dates from the time of Ambrose Paré. The procedures adopted by the older surgeons were simple enough. The torn surfaces were refreshed, and were united by sutures. In modern times innumerable modifications have been introduced. An essentially simple operation has been complicated by a number of intricate, and often ridiculous, methods. There is no form of suture designed by man that has not been tried upon the female perineum. The literature of the matter is voluminous and confusing, and is burdened with a perfect medley of ineffective terms. The subject has, in fact, been somewhat over-specialised, and the primary simplicity of the operation only becomes evident when it is freed of all such rags and tatters as do not belong to the bare elements of surgery.

All operations which involve elaborate suturing are difficult to describe and to illustrate clearly. We know of no better

account of the subject than the chapter in Dr. A. H. N. Lewers's Text-book of Diseases of Women, and we are greatly indebted to our friend and colleague, Dr. Lewers, for permission to use it freely in what follows.

Preliminary Treatment.—It is always advisable to close the rent as soon as possible after the laceration has been produced. This may be attended with success, but the success may, unfortunately, be partial only.

The Immediate Operation.—The patient should be anæsthetised and placed in the lithotomy position. The vagina and

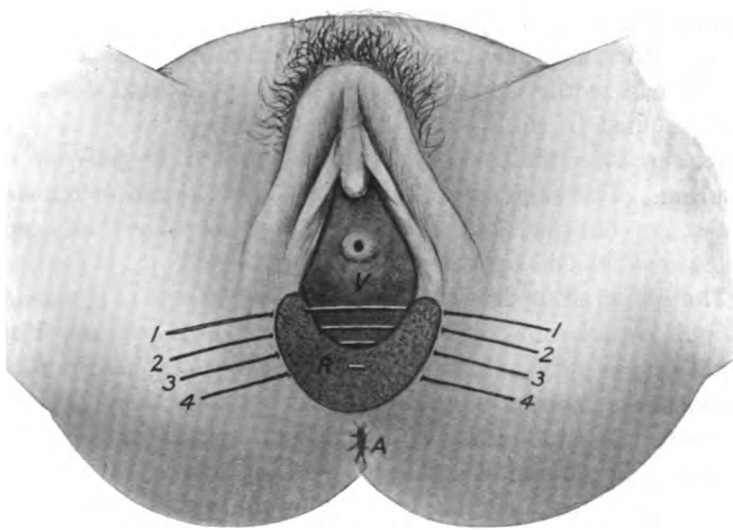


FIG. 127.—SUTURES IN OPERATION FOR RUPTURED PERINEUM.

surface of the wound should be thoroughly cleansed by irrigation with warm antiseptic lotions, taking care that they are not too strong. 1 in 100 carbolic acid is a suitable antiseptic, but the cleansing may be largely effected with plain boiled water. A sponge or pad is placed in the vagina to prevent secretion from contaminating the wound. Coloured silkworm gut is the best material for the sutures; it should not be too thick and should be softened by boiling immediately before use. Mounted

needles are sometimes employed, but, as Dr. Lewers observes, large well-curved needles in a holder are more convenient.

If the rent has extended through the sphincter ani into the rectum (this is comparatively rare), catgut or fine kangaroo-tendon sutures are first inserted at this end; they must bring the torn ends of the sphincter together, and may be buried by more superficial sutures through the anal skin.

The sutures which in the majority of cases are alone required are shown in Fig. 127. Three will suffice as a rule. They should include the whole depth of the wound except the lining membrane of the vagina. They are tied with moderate tightness, commencing with the posterior one. If necessary, a continuous catgut suture may be added for the vaginal mucous membrane.

The pad in the vagina is withdrawn, and a light dressing of gauze applied to the wound with a T-bandage.

In the after-treatment the great point is to prevent constipation. The main sutures are removed at the end of ten days; any catgut ones are left alone. There is no object in keeping the patient on her back after the operation.

The Deferred or Secondary Operation.—If the rent perineum has not been sutured immediately after labour, sufficient time should elapse for the parts to get into healthy condition. As a rule, many months have intervened between the rupture and the operation, which may, of course, be required if the attempt at immediate union has failed. The preliminary treatment is simple, the bowels should be thoroughly cleared, any vaginal discharge should be cured by astringent injections, the patient should rest in bed for a day or two before operation. If a complete septum still exists (as is usually the case) between rectum and vagina, the method of operation should be what has come to be known as Lawson Tait's. Dr. G. E. Herman points out ("Diseases of Women," 3rd edition, page 726) that long before Lawson Tait published his account of the method J. Hutchinson (senior) practised and taught it. The principle is to remove no tissue but to reconstitute the perineal body by means of lateral sutures after completely splitting the septum transversely.

Roughly speaking, it consists in converting the capital H into X. In Fig. 128, the line B E represents the transverse incision; to this is added an incision passing forwards and a little outwards on either side for an inch or more (B A and E D), and two shorter incisions passing for half an inch backwards and outwards (B C and E F). These latter incisions lie in reality nearer to the rectal wall than they appear in the figure. These incisions are steadily deepened with scissors or scalpel, taking care not to open either rectum or vagina, the fingers of the operator's left hand being introduced into the rectum to guard against this.

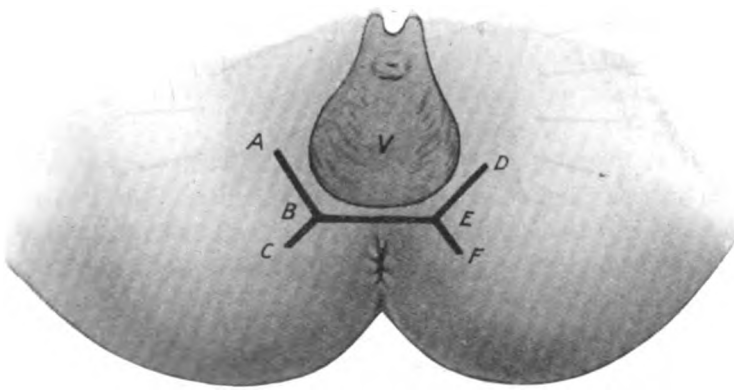


FIG. 128.—LAWSON TAIT'S OPERATION FOR RUPTURED PERINEUM. (*For explanation see text.*)

A deep wound is thus made having four curved (concave) sides, A C F D in Fig. 128. Ultimately the rectal and vaginal walls are so separated and drawn backwards and forwards as to allow A B C and D E F to be approximated. Silkworm gut on large curved needles is then passed on either side (1, 2, 3, 4 in Fig. 129), taking a firm hold and traversing the tissues to the bottom of the wound. If the edge of the vaginal wall A D or of the rectal wall C F is redundant, a triangular piece of mucous membrane is excised, and the small wound closed with interrupted sutures of catgut. These catgut sutures would be knotted on the vaginal and rectal sides respectively. The Clover's crutch is removed. The main silkworm-gut stitches are then tied

firmly, and a light gauze dressing applied. The urine should be drawn off with the catheter three times a day. The main sutures are removed at the end of ten days. The bowels must be kept regularly open. Most surgeons insist on the patient's knees being lightly bandaged together, but this is not essential.

Note.—Dr. Lewers describes and figures the main sutures as not passing through the skin at the sides of the wound; they are introduced one-eighth of an inch inside the edge of the wound. They will thus be buried beneath the skin, and to

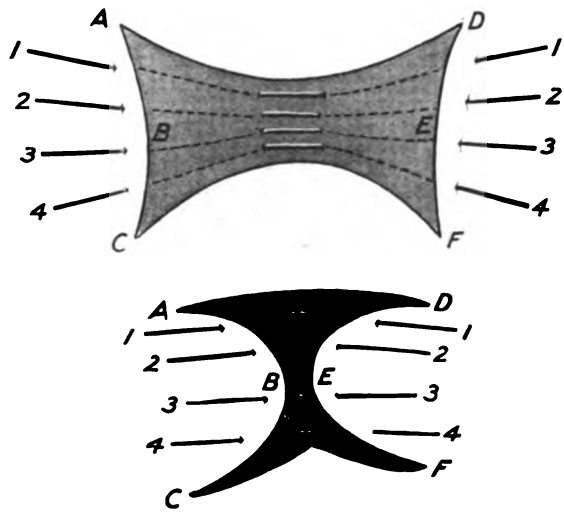


FIG. 129.—LAWSON TAIT'S OPERATION. (*See text.*)

remove them may be somewhat difficult. We see no reason against including the edges of the skin, as the subsequent removal will be facilitated thereby. Dr. Lewers also advises that the whole of the vaginal lining between A and D (Fig. 128) should be excised. We have, however, had excellent results without excising any of this lining. It is obvious that slight modifications may be made in any particular case.

Other Methods of Operating.—Amongst the many varieties of operation for ruptured perineum we consider the one described above (Lawson Tait's) as the best. The following account of

another method (Dr. Galabin's) is taken from that author's work on "Diseases of Women."

In the most usual circumstances the rupture will be of some weeks' standing when the case comes before the surgeon's notice, and the rent surfaces will have healed over.

It is desirable that the patient be in good health, and that there be no local complications. It is very important that the rectum should be empty, and that the intestinal canal should contain as little *débris* as possible. This is ensured by a few days' dieting, by the liberal use of aperients, and by the administration of an enema on the eve of the operation.

An existing vaginal discharge should be got rid of, if possible. The condition is not unfrequently complicated by piles; but unless these are of severe degree they form no obstacle to the operation.

The parts must be very thoroughly cleansed before the operation, and any hair upon the perineum may be shaved off.

Operation for Partial Rupture.—The patient is placed in the lithotomy position, and the thighs are supported by means of Clover's crutch. The buttocks are brought well up to the end of the table. The surgeon sits facing the perineum. Two assistants stand by the patient's pelvis, and each retracts the labium with one hand, while he sponges, and otherwise assists the operator, with the other. The extent of surface to be freshened is indicated, to some degree, by the cicatrix left by the laceration. "It is well, however, to go a little beyond the limits of this in all directions, especially up the median line of the vagina, and towards the lower halves of the labia majora, both in order to secure, if possible, a perineal body somewhat larger and deeper than the original one, and to allow some margin, in case the surfaces do not unite completely up to the edges. To put the mucous membrane on the stretch an assistant at each side places one or two fingers on the skin of the thigh, and draws the vulva outwards. The skin just beneath A (Fig. 130), in front of the anus, may also be seized by a tenaculum and drawn downwards. If still the mucous mem-

brane is not sufficiently on the stretch, from laxity of the vagina, the posterior vaginal wall, some distance above B, should be seized by long-handled tenaculum forceps and pushed upwards.

"Incisions are then made through the mucous membrane, from B to A, in the median line of the vagina, and from A to C and D, through the junction of the mucous membrane and

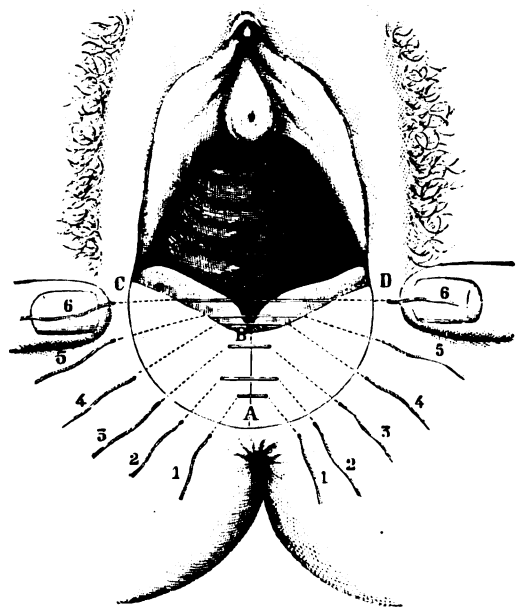


FIG. 130.—REPAIR OF RUPTURED PERINEUM. (*Galabin.*)

skin (Fig. 130). These should not be extended in the direction of C and D further than the lower extremity of the nymphæ at the utmost. There are then two triangular flaps—A B C and A B D. These are to be dissected up from the apex A towards the base B C and B D, the corner of the mucous membrane at A being seized with dissecting forceps. The dissection should not be deeper than necessary, and if it is done with the knife the surfaces are more ready to unite. If, however, there is much tendency to bleed, scissors may be used. The apices of the flaps are then cut off with scissors, leaving an upturned

border along B C and B D. When the surfaces are drawn together, these borders form a slightly elevated ridge towards the vagina; and if there be any failure of union just along the edge, they fall over and cover it" (Galabin).

Silkworm gut forms the best suture material. The sutures may be most conveniently introduced either by means of a curved needle in a handle or by means of a large Hagedorn's needle held in a holder. They should be introduced as shown in Fig. 130, the dotted lines representing the buried parts of the suture. The sutures 1, 2, and 3 may be buried along the whole length of their course. "If, however," writes Dr. Galabin, "they are brought out in the centre for spaces alternately short and long (Fig. 130), the surfaces are more easily brought into contact at all levels without undue tension."

The sutures 4, 5, and 6 are brought out close to the margin along which the folds of mucous membrane, B C B D, are turned up from the vagina, and are not passed through the mucous membrane itself.

The sutures are tied in order from behind forwards—*i.e.* from No. 1 to No. 6. As they are being secured, a stream of some antiseptic solution from an irrigator should be allowed to play over the surface, in order that no blood-clot may be enclosed in the depths of the wound.

Operation for Complete Rupture.—The preliminary measures, already described, having been taken, the operation is proceeded with as follows:—

"A point (B, Fig. 131) in the median line of the vagina, a sufficient distance above the apex of the rent in the septum, is taken, and an incision through the mucous membrane is made from B to G, and from G to E and F along the edges of the septum, between the rectal mucous membrane and the cicatrix. Incisions are also made through the skin from E to C, and F to D, so that the freshened surface may extend somewhat beyond the limits of the cicatrix, C or D not to be higher than the lower extremities of the nymphæ. The quadrilateral flap E G B C is then seized at E by dissecting forceps, and dissected up with

the knife from the angle E, and afterwards from the angle G, towards the base B C. While this is done the parts are kept on the stretch by an assistant drawing down the skin below E with a tenaculum. The flap is then cut away with scissors, except an upturned border, which is left along B C. The flap F G B D is treated in a similar manner. If, as is usual, the ends

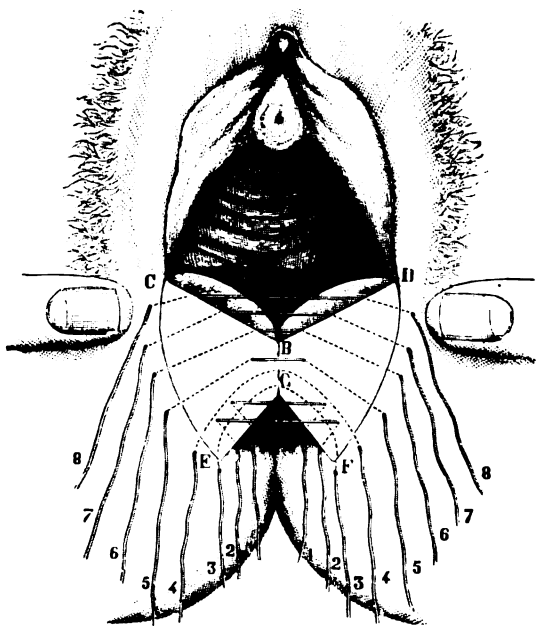


FIG. 131.—REPAIR OF RUPTURED PERINEUM. (*Galabin.*)

of the sphincter at E and F have retracted from the margin of the cicatrix, it is well to cut away with the scissors a narrow strip of rectal mucous membrane, generally somewhat everted, a short distance from E and F towards G, so as to bring the freshened surface to the ends of the sphincter.

"Sutures of silkworm gut are then applied in the following manner:—First rectal sutures, either two or three, according to the extent of the rent in the septum, are applied. These are destined to be tied in the rectum, and the ends left projecting through the anus. They are best applied with a half-curved

needle held in a holder. The needle is passed in a little distance from the margin of the rent, and brought out almost at the very edge of the rectal mucous membrane, on the line G F. The needle is then threaded at the other end of the suture, and that is drawn through in the same way from without inwards on the margin E G. Next, two sutures at least are passed completely round through the remnant of the septum by means of a curved needle, not too large, mounted in a handle. This is passed unthreaded, and draws the suture back with it on withdrawal. The first of these (3, Fig. 131) is passed in somewhat behind and below the angle F, so as to take up, if possible, or at least go quite close to, the end of the divided sphincter, and is brought out in a similar position near E. Thus, when tightened, it brings together the ends of the sphincter, drawing it into a circle ; but it often brings into apposition not so much the freshened surfaces above as the unfreshened rectal mucous membrane. This serves as a barrier to keep out fæcal matter, while the next suture (4) aids the rectal sutures in uniting the freshened surfaces. The remaining sutures (5 to 8) are passed, as shown in the figure, by a slightly-curved needle mounted in a handle, in the same way as in the operation for incomplete rupture " (Galabin).

When all the sutures are in position they are tied in the order of their numbers, and the operation is completed as in the previous account.

CHAPTER XIX

OPERATIONS ON THE KIDNEY

Anatomical Points (*see* Frontispiece and Plates XV. and XVI.).—The kidneys are deeply placed, and are most accessible to pressure at the outer edge of the erector spinæ just below the last rib. They rest about equally upon the diaphragm and the anterior layer of the transversalis aponeurosis, which latter structure separates them from the quadratus lumborum. They rest to a slight extent also upon the psoas.

The upper edge of the kidney corresponds with the space between the eleventh and the twelfth ribs, and with the eleventh or twelfth dorsal spine. The right kidney is a little lower than the left. The lower end of the kidney is about on a level with the middle of the third lumbar spine (Plate XV.). The hilum is about opposite to the gap between the first and second lumbar spines.

The inner border of the gland at its upper part is about one inch from the middle line; the outer border at its lower part is $3\frac{1}{4}$ inches from that line.

A horizontal line passing through the umbilicus will be one inch below the lower end of the right kidney, and one and a half inches below the left.

It must be noted that these levels vary considerably, and are to be taken only as representing the average. Moreover, the kidneys move to some extent with respiration.

A vertical line carried upwards from the middle of Poupart's ligament has one-third of the kidney to its outer side, and two-thirds to its inner side.

Draw two horizontal lines from the tips of the eleventh dorsal and third lumbar spines. Mark two points on each, the

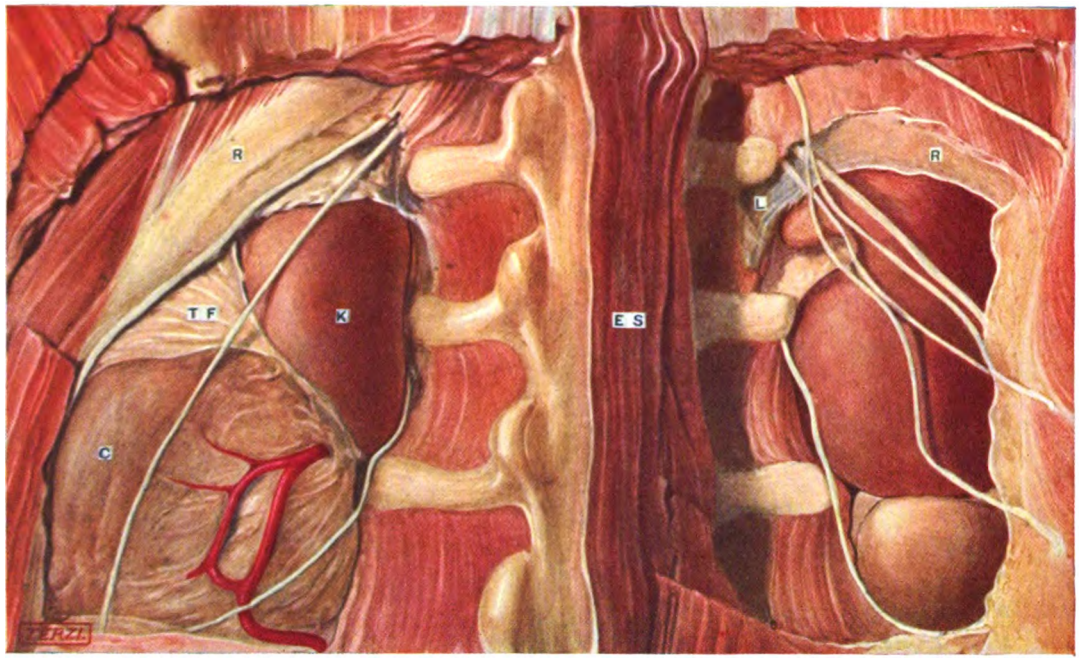


PLATE XV.—THE KIDNEYS FROM BEHIND, SHOWING THEIR RELATIONS TO THE LUMBAR VERTEBRÆ, ETC.

(From a Dissection in the London Hospital Museum.)

THE ERECTOR SPINÆ (E S) HAS BEEN DISSECTED AWAY ON THE LEFT SIDE, BUT RETAINED ON THE RIGHT. R, TWELFTH RIB, BELOW WHICH ARE THE LAST DORSAL NERVE AND BRANCHES OF THE LUMBAR PLEXUS. K, KIDNEY EXPOSED BY OPENING ITS SPECIAL CASE OF TRANSVERSALIS FASCIA (T F). L (ON RIGHT SIDE), INTERNAL ARCUATE LIGAMENT. THE TRANSVERSE PROCESSES OF THE FIRST, SECOND, AND THIRD LUMBAR VERTEBRÆ ARE EXPOSED, THE RENAL HILUM ON THE RIGHT SIDE BEING SHOWN OPPOSITE THE SECOND VERTEBRA. THE COLON (C) IS EXPOSED ON BOTH SIDES, AND ITS DIFFERENT RELATIONS TO THE KIDNEY SHOULD BE NOTED.

first 1 inch, the second 3¼ inches from the middle line. Through each of these pairs of points draw vertical lines. The parallelogram thus marked out bounds the posterior surface markings of the kidney.

In relation with the anterior surface of the right kidney are the under-surface of the liver, the second part of the duodenum, the commencement of the transverse colon, and the ascending colon.

In the same relation on the left side are the fundus of the stomach, the pancreas, and the descending colon.

Crossing the posterior surface of the kidney obliquely from above downwards and outwards, are branches of the last dorsal nerve, and of the first lumbar artery, together with the ilio-hypogastric and ilio-inguinal nerves.

The fatty tissue in which the kidney and its true fibrous capsule are embedded is of surgical importance. It is termed the fatty capsule, and is of interest both with regard to operations upon the kidney and to the pathology of injuries to and inflammations around the kidney and ureter. Fat in any quantity is not present within this capsule until about the tenth year of life; but after this age it is found as thick pads, disposed mostly behind and below the kidney. It serves a function, like the fat of joints, to adapt the moving kidney to the space in which it moves, and to the variations of the intra-abdominal pressure, but takes no active part in suspending the kidney. It is traversed by fine, loose connective-tissue fibres, which pass from the true fibrous capsule of the kidney to the perinephric fascia, and are specially well-marked at both poles of the kidney, where they often cause difficulty in the enucleation of the kidney. These fibres contain fine blood-vessels which, when torn across, may lead to troublesome oozing.

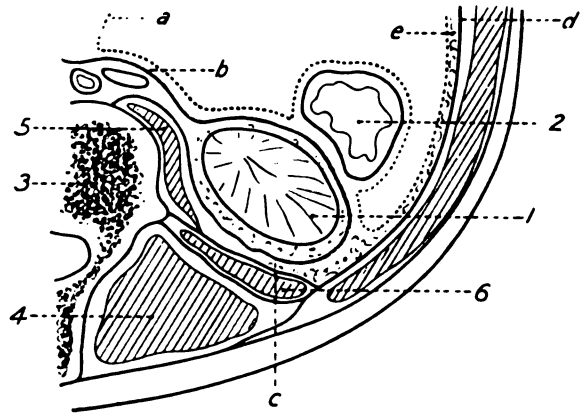
The perinephric fascia forms a clearly defined outer fibrous capsule for this fat, and lies interposed between the transversalis aponeurosis behind and the peritoneum in front, being formed by two fibrous sheets, anterior and posterior (Plate XVI.).

The anterior layer is thin and lies closely applied to the back of the peritoneum, from which, however, it is quite distinct, passing across the anterior surface of the kidney, suprarenal, vertebræ, vena cava, and aorta, to fuse with its fellow of the opposite side. The posterior layer is thicker, and is attached to the sides of the bodies of the lumbar vertebræ just in front of the heads of origin of the psoas muscle. Thence it passes outwards in front of the anterior layer of the transversalis aponeurosis which lines the psoas and quadratus, and behind the kidney to sweep round the outer border of that organ and fuse with the anterior layer. The fascia thus presents a rounded convex surface to the operator as he approaches the kidney from the back of the loin at the outer border of the quadratus muscle, which is the guide to the fascia.

At the upper pole of the kidney both layers fuse firmly together, and then split again to enclose the suprarenal body to the capsule of which they are firmly attached. At the upper border of the suprarenal they unite again and obtain a firm attachment to the fascia lining the diaphragm. These facts explain how it is that the suprarenal body is not encountered during operations on the kidney, and why the suprarenal does not descend with the kidney in cases of nephroptosis. In other words, the kidney lies in a separate compartment of the perinephric fascia.

Below the kidney the two layers pass downwards as a loose tubular sheath attached to the vertebræ on the inner side, loosely enclosing the ureter and spermatic vessels, and extending outwards some two inches from the vertebral column before they fuse together on the outer side.

The ureter is attached somewhat firmly along its anterior surface only to this sheath, and so to the peritoneum, but is quite free behind. It tends, therefore, to fall forwards with the peritoneum during operations for exposure of the ureter from behind. During the exposure of the kidney from behind the perinephric fascia should always be recognised at the outer border of the quadratus muscle immediately after the trans-



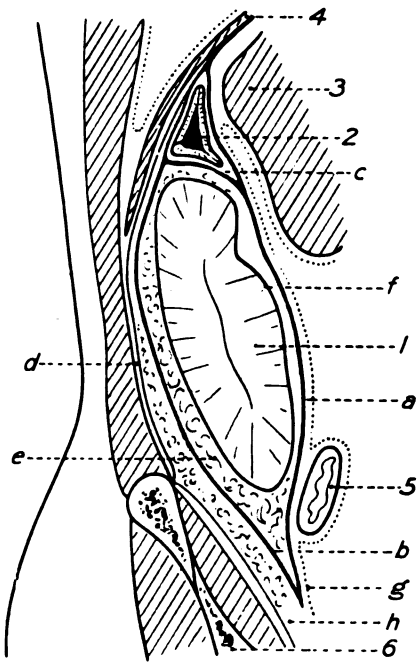


PLATE XVI.

FIG 1.—TRANSVERSE SECTION OF LOIN TO SHOW THE ARRANGEMENT OF THE PERINEPHRIC FASCIA.

1, KIDNEY. 2, COLON. 3, VERTEBRA. 4, SACRO-LUMBALIS MUSCLES. 5, PSOAS MUSCLE. 6, QUADRATUS LUMBORUM (OUTER BORDER THE GUIDE TO THE PERINEPHRIC FASCIA). A, PERITONEUM. B, ANTERIOR LAYER OF PERINEPHRIC FASCIA. C, POSTERIOR LAYER OF PERINEPHRIC FASCIA. D, TRANSVERSALIS FASCIA. E, SUBPERITONEAL FAT.

FIG. 2.—LONGITUDINAL SECTION OF LOIN TO SHOW THE ARRANGEMENT OF THE PERINEPHRIC FASCIA.

1, KIDNEY. 2, SUPRARENAL BODY. 3, LIVER. 4, DIAPHRAGM. 5, COLON. 6, PELVIC BONE AND MUSCLES. A, ANTERIOR LAYER OF PERINEPHRIC FASCIA. B, POSTERIOR LAYER OF PERINEPHRIC FASCIA. C, THE FASCIA AS IT SPLITS TO ENCLOSE THE SUPRARENAL BODY. D, TRANSVERSALIS APONEUROSIS. E, FAT AND CELLULAR FIBRES CONTAINING BLOOD-VESSELS BETWEEN KIDNEY AND PERINEPHRIC FASCIA. F, TRUE FIBROUS CAPSULE OF KIDNEY. G, PERITONEUM. H, FAT BEHIND PERINEPHRIC FASCIA.

versalis fascia has been cut through. It should be held up between two pairs of forceps and incised, when a little perirenal fat at once rises through the opening, which is next enlarged and a finger inserted. The finger cannot then fail to feel the kidney inside its fatty capsule, and to strip it cleanly from its bed of fat.

The structures which enter the hilum of the kidney form also the surgical pedicle of the kidney. They consist of the renal vessels, the pelvis of the ureter, lymphatics, nerves, and connective tissue.

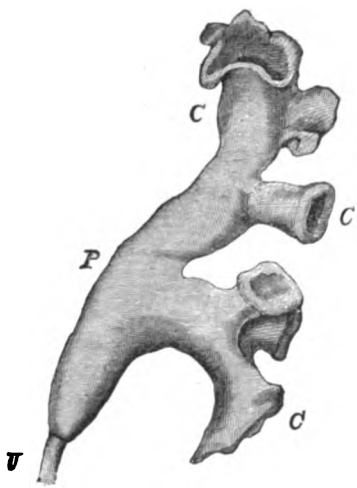


FIG. 132.—CAST OF THE INTERIOR OF THE UPPER END OF THE URETER. (*Henle.*)

U, Ureter; P, Pelvis; C, Calyces.

The renal artery is the size of the brachial and divides just before reaching the hilum into four or five branches. One of these runs backwards round the upper border of the pelvis, to enter the kidney behind the pelvis, and supply the posterior portions of the kidney, roughly a quarter of the organ. The others run out in front of the pelvis and are distributed to the anterior portions of the kidney, roughly three-quarters of the organ. Knowledge of the method of distribution of these vessels is of some surgical importance, as the method of incising the kidney in nephrolithotomy may be based upon it. A paper by Max Broedel on this subject appeared in the *Johns Hopkins Bulletin* for January, 1901, No. 118, to which the reader is referred for further details; and in which he shows clearly the arrangement of the renal pelvis and its vessels. Figs. 138 and 139 are taken from this paper.

The renal artery may be replaced by two, three, four, or even five branches, which usually come off directly from the side of the abdominal aorta, but may take origin from the lumbar,

iliac, or inferior mesenteric arteries (Fig. 133). They may pass directly to the hilum, or may be distributed to the poles, or any portion of the inner surface of the kidney. They may run behind, but more usually run in front of the pelvis and ureter. Where such abnormal vessels are present, the fœtal lobulation of the kidney tends to persist, and gives a valuable hint at operation that the arteries should be examined forthwith.

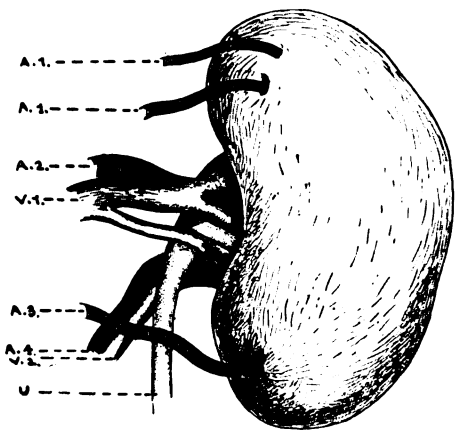


FIG. 133.—ABNORMAL ARRANGEMENT OF THE RENAL VESSELS. (*From a dissection in the London Hospital Museum.*)

A.1, Two small arteries entering the summit of the kidney; A.2, Chief renal artery entering the hilum in front of the ureter and in front of V.1, the chief renal vein; A.3, Arterial branch from the aorta crossing in front of the ureter to the lower end of the kidney; A.4 and V.2, Artery and vein running upwards to the hilum behind the pelvis of the ureter; U, Ureter.

(The kidney is viewed from behind.)

These abnormal vessels are not a matter for surprise if it be remembered that the kidney and ureter arise in the pelvis as buds from the Wolffian duct, and travel up to their position in the loin, and that the renal arteries normally grow out from the aorta to vascularise the kidney bud after it has reached its proper position in the loin.

The lower division of the renal artery divides into three branches to supply the lower pole of the kidney. One of these arteries in a large number of bodies is found to arise directly from the aorta, and may pass to the tail of the kidney, sometimes accompanied by a vein either in front of or behind the junction of the ureter and renal pelvis. When it passes behind, trouble is bound to arise sooner or later. The ureter becomes kinked as it runs to the pelvis over the rigid tail-artery, which leads to a valvular ureteric opening, dilated pelvis, hydronephrosis, pyonephrosis, stone, and perinephritic inflammation.

An instance is figured of this condition (Fig. 134), which is by no means uncommon, and is often mistaken for tuberculosis or stone. (Compare A.3. in Fig. 133 with A′ in Fig. 134.) Symptoms may not arise until adult life, and the diagnosis can only be made by an exploratory measure. Fœtal lobulation is always persistent in such cases.

The renal arteries are "end" arteries, so that when they are cut across, the tissues supplied by the cut vessel undergo necrosis.

There are constantly present a number of fine arterial twigs supplying the capsule and even part of the cortex of the kidney, which are not derived from the true renal arteries, but come from the lumbar or suprarenal vessels. In the cases of congenital displacement of the kidney mentioned below, the main renal arteries may be derived from the common or internal iliac vessels or even in part from the middle sacral (which is a rudimentary prolongation of the abdominal aorta).

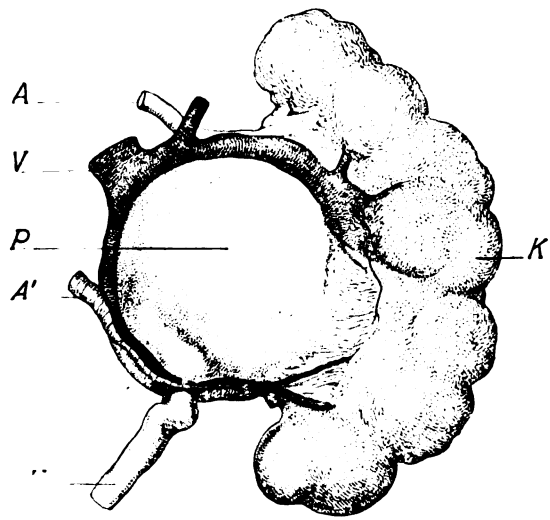


FIG. 134.—HYDRONEPHROSIS CAUSED BY KINKING OF URETER (U) OVER AN ABERRANT RENAL ARTERY (A′) AND VEIN. (*Specimen prepared and drawn by Mr. F. S. Kidd.*)

K, Elongated kidney with congenital lobulations persisting; P, Greatly dilated pelvis; V, Trunk of renal vein; A, Upper and main part of renal artery. In such a case, operation and division of the aberrant renal vessels between two ligatures will result in cure.

With regard to the veins of the kidney, it should be noted that there is a fine network all around the organ which communicates with the lumbar, suprarenal, spermatic, ovarian, and phrenic veins, and those accompanying the adjacent last dorsal

and lumbar nerves. Hence when the kidney is detached from its fatty capsule there is usually considerable venous oozing, which needs careful attention before the wound is closed.

The renal veins do not take the same course as the arteries (*see* Figs. 138 and 139). Their distribution within the kidney is different, and corresponds to the arrangement of the pyramids. They all pass in front of the pelvis, and join to form a single trunk which passes transversely inwards to enter the vena cava. Both vessels enter the vena cava at about the same level (*see* Frontispiece).

There is, however, an important difference between the length of the right renal vein and that of the left. The right kidney normally touches the vena cava at its upper end, and the right renal vein is rarely more than one inch long (frequently less); whilst the left renal vein, which crosses the aorta, is usually from two to three inches long. In performing nephrectomy on the right side many accidents have happened owing to the shortness of the renal vein—the vena cava having been wounded or ligatured in several cases (there is an example of the latter in St. Bartholomew's Hospital Museum). The close relation of the right kidney to the vena cava and the resulting shortness of the renal vein on this side must always be remembered.

The ureter loses its cylindrical form on a level with the lower end of the kidney, where it begins to expand into the funnel-shaped cavity called the pelvis (Fig. 132). After entering the hilum the pelvis divides into two, or even three, primary tubular branches, which in turn end in several truncated short and wide pouches, the calyces. In the pelvis of the ureter, or in the calyces, calculi are frequently lodged (Fig. 137). The calyces are normally too narrow to admit of the introduction of the finger for exploration, but are frequently dilated by disease.

The abnormalities of the kidney are of considerable surgical importance. They are very fully dealt with in Mr. Henry Morris's work on "Surgical Diseases of the Kidney and Ureter."

One, or less frequently both kidneys, may be congenitally

misplaced. The left is more often out of place than the right, and the organ may be found over the sacro-iliac synchondrosis, or the promontory of the sacrum, or be discovered in the iliac fossa or pelvis. The misplaced kidney is often misshapen, and may exhibit a more or less extreme degree of lobulation. The ureter may be double.

The two kidneys may be fused. "The lowest degree of fusion is seen in the horseshoe kidney. The two kidneys are united at their inferior portions by a flat, riband-like, or rounded bridge of tissue, which crosses the vertebral column. In the higher degrees the two lateral portions approach one another more and more, until they reach the highest degree, in which a single disc-like kidney, lying in the median line, and provided with a double or a single calyx, represents complete fusion" (Rokitansky).

When the two kidneys are united by a web of connective tissue, the condition is no bar to operation.

There may be an entire absence of one kidney. The single kidney may be lateral or median in position.

Mr. Henry Morris estimates that congenital absence or extreme atrophy of one kidney may be expected to be present in 1 in about 4,000 cases.

The horseshoe kidney may be looked for in the proportion of 1 to every 1,600 cases, and the single fused kidney in 1 in about 8,000 cases. Examples of wasted, small, and shrunken kidneys are certainly much more common than this amongst those patients who are the subjects of renal operations, but they are the result of disease rather than congenital variations.

In a recent autopsy at the London Hospital a single kidney was present on the right side. The right ureter was normal, the left ureter was normally placed in relation to the bladder and pelvis, but when it reached the left renal fossa it passed to the right across the aorta, and was inserted into the upper portion of the right renal pelvis. In this case the cystoscope would have given misleading evidence as to the presence of a left kidney.

The kidney and ureter are supplied by nerves from the sympathetic system, which run out of the spinal cord from the tenth dorsal to the second lumbar segments. In cases of obstruction to the pelvis and ureter one or more of the areas of skin supplied by the same segments may become tender.

History of Operations upon the Kidney.—It would appear that during the earlier days of surgery incisions had been made from time to time into fluctuating swellings in the loin, and through such wounds abscesses and cysts were evacuated which were subsequently shown to have had origin in the kidney.

In like manner, ancient records contain accounts of cases in which renal calculi were removed through the loin, their discharge having followed the evacuation of an abscess in that region. These early operations were all more or less casual.

The possibility of removing stones from the kidney is discussed by more than one ancient writer, and such a measure of treatment was now and then advised in the vague, haphazard, and irresponsible language that marks many of the earlier surgical records.

A case is recorded in the *Philosophical Transactions* for 1696 by Dr. Bernard, which would seem to have been one of nephrolithotomy. Some discredit has been cast upon the case, and the details of it are not sufficiently complete to make it of scientific value. The case certainly had no influence upon surgical practice.

It is usually stated that the first operation of nephrolithotomy was performed by Mr. Henry Morris in 1880. The operation was deliberately undertaken and carefully planned, and it forms the basis and starting point of the modern procedure. It should, however, be recorded that on Dec. 26th, 1879, Mr. John Couper removed four large calculi from the right kidney of a woman in the London Hospital. This case should really take priority of Mr. Morris's.

Nephrectomy had been performed unintentionally several times before it was deliberately carried out as a precise operation by Gustav Simon, of Heidelberg, in April, 1869. The operation was performed for an intractable fistula of the ureter, and the patient made an excellent recovery. In Mr. Barker's article in the *Med.-Chir. Trans.*, vol. lxiii., will be found an account of the first twenty-eight reported

cases of nephrectomy. Nephrorraphy was first performed by Dr. Hahn, of Berlin, in April, 1881. Since the various operations were introduced the development and application of each measure have been very rapidly extended. A complete account of the subject will be found in Mr. Henry Morris's work on "Surgical Diseases of the Kidney and Ureter."

The following operations will be described :—

1. Exposure of the kidney, pelvis, and lumbar ureter (perinephrotomy).
2. Nephrolithotomy. Pyelolithotomy.
3. Nephrotomy. Nephrotresis.
4. Nephrectomy, partial and complete.
5. Nephrorraphy, or nephropexy.
6. Uretero-lithotomy.
7. Ureterotresis and plastic operations on pelvis and ureter.

1.—Exposure of the Kidney, Pelvis, and Lumbar Ureter (Perinephrotomy)

This procedure is adopted :—

(1) As a preliminary step to further operation on the kidney.

(2) As an exploratory procedure in order to make an anatomical diagnosis; for instance, in cases of hydronephrosis or renal hæmaturia of unknown origin.

(3) In certain cases of extravasation into the loin caused by rupture of the kidney, for purposes of exploration and drainage or perhaps of nephrectomy.

(4) In cases of perinephritic abscess.

(5) To determine the presence and condition of one kidney when considering the question of excising the other.

Instruments Required.—Scalpels; bistouries; dissecting, toothed and pressure forceps; long sponge-holding forceps; several pairs and varieties of dissecting forceps nine inches long for dissecting out the ureter; broad and narrow, rectangular and curved, metal retractors; trocar; cannula; half a dozen

small round sponges; a loin-cushion; arm-rest; a head-lamp.

Preparation of the Patient.—The preparation of the patient should be upon the lines already laid down in dealing with abdominal section. During the time of preparation it is imperative to ascertain the condition of the heart and lungs, and to estimate the excretory power of both kidneys together, and also of each separately when it is considered likely that the question of nephrectomy may arise, in which case it should not be forgotten to obtain the consent of the patient to that measure.

It is desirable that the bowels, and especially the colon, should be as well emptied as possible, as a distended colon bulges into the wound and is in a position of danger. The skin over the site of the intended incision should be carefully prepared with full antiseptic precautions.

Two methods of operating will be described—namely, the lumbar or posterior method, and the abdominal or anterior method.

A.—THE LUMBAR OPERATION

The patient lies upon the sound side with the back as near to the edge of the table as possible, the hips and knees flexed, and the uppermost arm supported by an arm-rest. The loin of the affected side is well exposed, and to widen the interval between the last rib and the crest of the ilium a narrow hard cushion or sand-bag is placed under the loin of the sound side.

The surgeon stands by the patient's back leaning over the trunk; the chief assistant stands on the opposite side, his duties being to sponge the wound and to press up the kidney towards the loin when necessary; an assistant stands on the right of each, whose sole duty is to hold the retractors in the wound.

The twelfth rib should be definitely recognised and well defined. It is occasionally absent or rudimentary, and then the pleural sac descends below the eleventh rib, which (unless the precaution is taken of counting the ribs from above) may

be mistaken for the twelfth (*see* page 495). At the examination of the radiogram the condition of the twelfth rib should always be noted and the width of the costo-iliac space.

An oblique incision is made across the costo-iliac space. The upper end of the cut begins half an inch below the last rib at

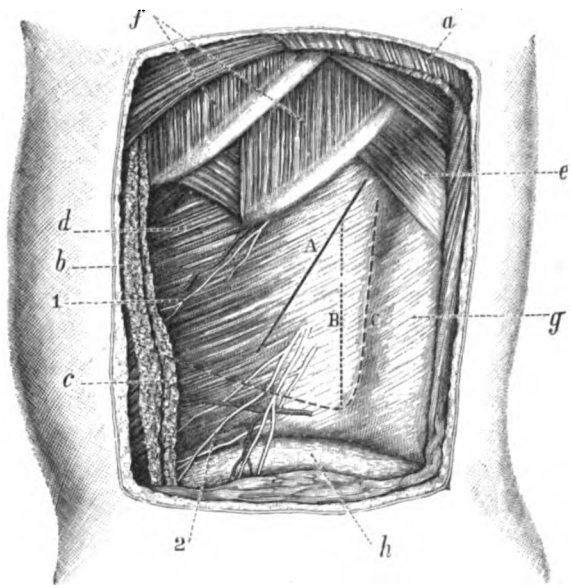


FIG. 135.—OPERATIONS ON THE KIDNEY.

A, Incision for exploration, for nephrotomy and nephrolithotomy; B, Additional incision for nephrectomy; C, König's lumbo-abdominal incision for nephrectomy.

a, Latissimus dorsi; *b*, External oblique; *c*, Internal oblique; *d*, Transversalis; *e*, Serratus posticus inferior; *f*, Intercostals; *g*, Fascia lumborum over erector spinæ; *h*, Crest of ilium; 1, Intercostal nerve and artery; 2, Twelfth dorsal nerve and lumbar artery.

the outer border of the erector spinæ. It is continued downwards and forwards towards a point one inch above the upper extremity of the anterior superior spine of the iliac crest. It will suffice if it is at first four and a half inches in length, and it may be enlarged subsequently as required. Other forms of incision are alluded to in the comment upon the operation (page 494).

After the skin, superficial fascia and fat have been divided,

the outer border of the latissimus dorsi and the hinder border of the external oblique muscles are exposed. The fibres of both are vertical, and they are divided to the full length of the skin incision. The sheath of the erector spinæ muscle should not be opened. The internal oblique muscle and the posterior aponeurosis of the transversalis muscle (fascia lumborum) are now laid bare. The fibres of the former muscle run upwards and inwards. Both muscle and aponeurosis are divided to the full length of the wound, care being taken not to divide the peritoneum which lines the front part of the fascia in the fore part of the wound, or to injure the colon.

At the outer border of the quadratus muscle the last dorsal nerve will be encountered as it runs forwards and downwards into the oblique muscles, parallel with the line of incision. The operator should be at special pains to preserve this nerve intact and to avoid bruising it with retractors. On no account should he excise any portion of it, and if he is so unfortunate as to cut it across he should reunite the cut ends with fine catgut at the end of the operation. Section leads to persistent hyperæsthesia of the skin in the area supplied by the nerve (*see* page 496). Several small vessels are cut on the face of the muscles and require immediate ligature, as artery forceps are in the way.

The outer edge of the quadratus lumborum and erector spinæ should not be cut unless it is absolutely necessary to enable the kidney to be protruded on to the surface, as such a step weakens the muscles of the back.

Broad metal retractors are placed in the wound and held by assistants.

The perinephric fascia is now seen as a glistening white membrane lying immediately outside the outer border of the quadratus lumborum.*

At this point it is deliberately picked up between two pairs of toothed forceps and incised. The perirenal fat bulges out

* In women with enteroptosis the liver on the right side often bulges into the wound. This must not be mistaken for the kidney and the peritoneum opened to expose it.

at once through the opening, which is then enlarged freely up and down. The margins having been fixed by pressure forceps, a finger is inserted and feels for the kidney lying in its bed of fat. While the chief assistant presses on the abdomen so as to force the kidney out and back, the operator tears away the excess of perirenal fat with sponge-holding forceps, till the postero-external surface of the kidney can be clearly seen in the depths of the wound. At this point an electric head-lamp is put on, and the operator proceeds to clear the poles and anterior surface of the kidney from its bed of fat, stripping the peritoneum well forward, and using the fingers freely. This is a matter requiring some patience if there has been long-standing inflammation of the kidney, as the adhesions are dense and bleed freely. It will be found of advantage to go straight on and dissect out the upper end of the ureter, by means of two pairs of special long dissecting forceps aided by an occasional touch with the knife, and trace it upwards to the pelvis of the kidney, as the cause of many obscure cases is in this way cleared up at once. The ureter falls forward with the peritoneum to which it is closely attached. At this stage great care must be taken not to tear the peritoneum, an accident to be avoided at all costs when the kidney is inflamed, as it may lead to peritonitis. Tuberculous peritonitis is a not uncommon sequel of this accident when a tuberculous kidney is being dealt with.

A fairly complete exploratory examination of the kidney, pelvis, and ureter can now be made. In certain cases it may be necessary to protrude the kidney through the wound. This is often impossible in the case of men, and should always be avoided unless absolutely necessary, as it adds greatly to the shock, and there is risk of tearing the renal pedicle. In women it is more often possible and permissible. Where, however, a thorough examination of the kidney is found to be impossible without this step, the operator should not hesitate to make the attempt rather than fail in his diagnosis.

Procedures suitable to the various conditions that may be encountered are now undertaken, and will be described under

their proper headings. In cases of perinephric abscess or extravasation of urine, a large indiarubber tube is inserted into the perirenal space, and the wound closed. In cases of hydronephrosis caused by an abnormal renal artery, the artery is divided between two silk ligatures and the ureter released. When the operation has been done on account of traumatic hæmaturia, etc., and a gravely damaged kidney is found surrounded by blood and extravasated urine, nephrectomy will probably be required. Fig. 136 is taken from such a case; the patient was a girl whose abdomen had been run over: she recovered quickly after the operation.

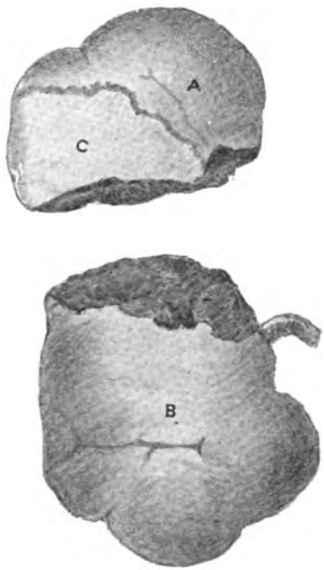


FIG. 136.—KIDNEY SEVERED IN TWO BY TRAUMATISM, AND REMOVED BY LUMBAR NEPHRECTOMY. (AUTHORS' CASE.)

A, Upper, and B, lower portion of kidney with ureter; C, Portion becoming gangrenous. The operation was performed a few days after the accident.

Closure of the Wound.—The recesses of the wound are carefully explored for bleeding points, especially for the torn, oozing veins of the perirenal fat, which are picked up and tied. This oozing renders drainage of the perirenal space advisable, even though there is no leakage of urine. A large indiarubber tube should, therefore, be passed down to the back of the kidney and stitched into place. The wound in the parietes is closed in layers, and tendon or stout chromicised catgut used to unite the cut muscles, care being taken to spare the last dorsal nerve. The skin is closed with silkworm gut. The wound is dressed with large masses of sterile gauze and wool; the front of the loin should be padded as a support to the kidney, the whole being secured by means of a firmly applied flannel bandage or binder, which serves to support the weakened belly wall and to ward

off shock. Care must be taken to roll the patient over on to the back after the operation, and during convalescence, as lifting movements put undue strain upon the sutures.

After-treatment.—The patient is placed in bed with the foot of the bed raised by means of six-inch blocks. This lessens shock, and encourages the kidney to fall back into its proper position. When the kidney has been enucleated, and especially when it is unduly movable, this position should be maintained for ten days until the kidney has again become firmly healed in its proper position. The patient should be rolled at intervals on to the side of the wound for some hours, so as to encourage drainage. He should be encouraged to drink freely of plain water from the first, and a pint or two of warm salt solution introduced into the rectum will often relieve his thirst better than any other measure. Rectal feeding is not required, and as soon as the vomiting has ceased milk can be safely administered by the mouth. The bowels should be encouraged to act upon the third morning after the operation, as flatus is particularly apt to accumulate and prove troublesome after manipulation of the kidney.

The bladder must be carefully watched for signs of retention of urine, which, if undoubtedly present, should be relieved by catheterisation ; but it should be remembered that in many cases little urine is passed during the first twenty-four hours, because little is secreted. Suppression of urine is best met by copious drinking, and by rectal and subcutaneous saline infusion. When pain is excessive there need be no hesitation in the exhibition of morphine. Some authorities recommend a course of urinary antiseptics during convalescence, with the idea of diminishing the risks of blood infection of the bruised kidney. These should be combined with large draughts of water.

As regards the lumbar wound, the dressings should be changed as often as they become soaked through, care being taken to roll the patient rather than to lift him during these manipulations, and to pay attention to the skin of the back. When the wound

remains clean, the tube can safely be removed altogether on the fourth day, when the wound will heal up quickly from the bottom. There is no need to substitute a gauze drain, and the wound heals better without it. If there is much suppuration the tube may be shortened gradually, and finally removed. The skin round the wound must be kept very clean, and if it becomes inflamed it should be covered with some antiseptic ointment to protect it from the urine. The wound usually heals quickly, but the patient should remain in bed at least three weeks to ensure a sound scar. Women should wear a belt as soon as they rise, and for at least six months afterwards.

Modifications and Complications of the Operation.—Many other incisions have been used for this operation. The one already described has the following advantages: It avoids the lower limit of the pleural sac, it leaves the quadratus lumborum and erector spinæ intact, and it can be prolonged downwards and forwards as much as may be desired above the iliac crest and parallel to Poupart's ligament, if it is found necessary to enlarge the wound and expose the whole of the lumbar ureter. Many surgeons prefer an incision (A, Fig. 135) which, starting from the same point above, slopes more rapidly down to the fore part of the iliac crest. This also can be prolonged forwards if desired, and additional room may be gained by converting the usual lumbar incision into a T-shaped one by cutting downwards and backwards towards the crest of the ilium (*see* under Nephrectomy, page 520).

Mr. Mayo Robson advises a "gridiron" incision, the skin being cut along a line which runs obliquely backwards from the anterior superior spine to the tip of the last rib.

Occasionally the lower end of the kidney barely reaches below the twelfth rib. In such cases Mr. Morris advises that an upward incision be made over the last rib, a little posterior to the front extremity of the oblique wound. Excision of some inches of the twelfth rib may be performed.

Some operators prefer to place the patient prone upon the table, with a large cushion beneath the abdomen. This position

increases the width of the ilio-costal space, lifts the kidneys towards the operator, and is of advantage when it is desired to expose both kidneys.

It is important that the twelfth rib be clearly defined and identified by counting the ribs from above downwards. The last rib is not unfrequently rudimentary, and when the pleura descends in such a case below the lower edge of the eleventh rib, it may readily be wounded if the incision be carried upwards. This happened in a case reported by Dr. Dumreicher. It has been shown that the last rib is often so short as not to reach as far as the outer margin of the sacro-lumbalis muscle, and such a structure may readily be mistaken for the transverse process of a vertebra. Even when the last rib is of normal size, the pleura may descend below it; and this would appear to have been the condition of things in a case of Mr. Thornton's, in which he wounded the pleura, but in which no costal abnormality is noted. The radiograph is of service in this connection.

The operation may be somewhat complicated by an excessive amount of subcutaneous fat. In certain cases some of this may be dissected away.

Rigidity and possible thickening of the muscles in some cases of long-standing disease may raise a difficulty in the way of the operation, and a still more serious obstacle may be due to the matting of the tissues together around the kidney. These inflammatory adhesions and organised deposits of plastic lymph may greatly complicate the operation.

Some difficulty has been experienced in finding the kidney through the lumbar incision. Mr. Bruce Clarke mentions a case in which "an hour elapsed before the kidney could be found." This is unlikely to happen if the perirenal fascia be recognised and incised before search is made for the kidney.

The organ when found may be difficult to deal with. It may be unduly covered by the ribs, or may be firmly fixed by inflammatory tissue to the surrounding structures.

The last dorsal nerve may become involved later in scar tissue which leads to a persistent pain along the area of

distribution of the nerve. How to prevent this is a problem that must be considered. If some inches of the nerve be excised the patient will still suffer from hyperæsthesia of the denervated skin area caused by the overlapping of the "protopathic" fibres of the adjacent segmental nerves. The surgeon should therefore take care to avoid bruising of the nerve or including it in the muscle sutures, and to re-unite it at once if cut across. If an operation becomes necessary at a later date for painful scar, the nerve is exposed, dissected clean from the scar tissue, surrounded by Cargile membrane or gold-foil, dropped back, and the wound closed. If the nerve has been cut and the central end cannot be found, nerve anastomosis should be performed with a branch of the first lumbar nerve.

B.—THE ABDOMINAL OR ANTERIOR OPERATION

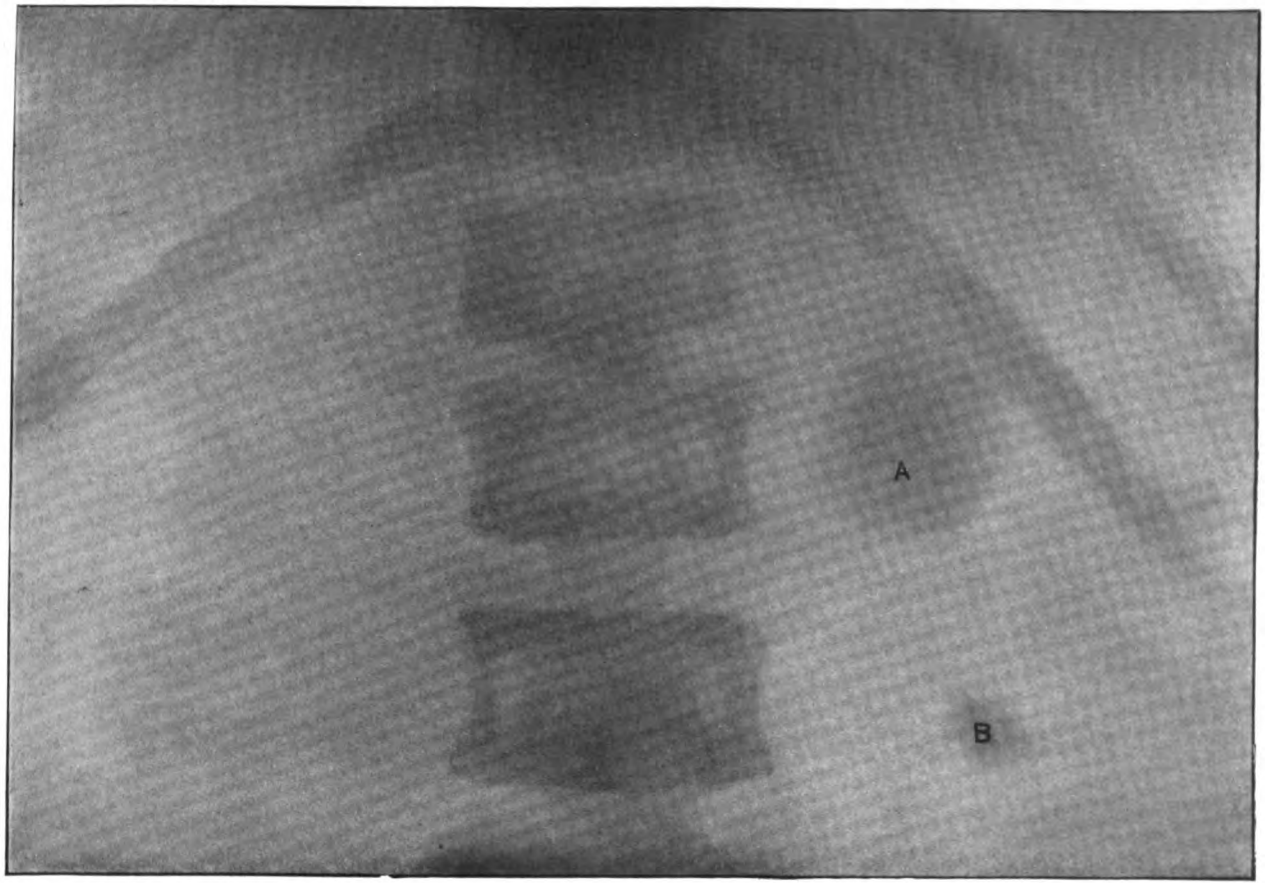
Langenbüch's Incision.—The steps of this operation are described under Abdominal Nephrectomy (page 526). When it is performed for intraperitoneal rupture of the kidney, the bleeding is first stayed by suture of the ruptured organ, the peritoneal cavity is then cleansed of blood by irrigation with salt solution or by local dry sponging, a counter opening is made in the loin to take a drainage tube, the torn peritoneum is carefully sutured with fine silk and the abdominal wound completely closed.

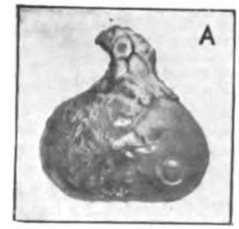
2.—NEPHROLITHOTOMY. PYELOLITHOTOMY

The operation of incising the kidney for the purpose of removing renal calculi has been carried out with remarkable success in a long series of cases.

Discrimination must be exercised in selecting subjects for operation, and the diagnosis should be as clear as possible. The symptoms of renal calculus may be simulated by several other conditions, and a long list of cases might be collected in which an exploratory operation has failed to reveal calculus, although in some it was really present.

The value of the Röntgen rays as an aid to diagnosis is





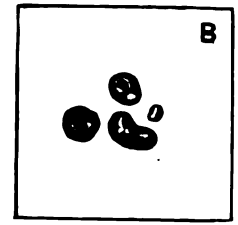


PLATE XVII.—RADIOGRAPH OF CALCULI IN KIDNEY, WITH THE STONES REMOVED, TO SHOW THE EXACT CORRESPONDENCE IN SIZE.

A, LARGE OXALATE STONE. B, GROUP OF SMALL CALCULI IN ONE CALYX, SHOWING AS ONE SHADOW.

considerable. Unless the patient be very stout, the method will usually indicate the presence of a stone, its size and position, and whether there is more than one (Plate XVII.).

A well-marked shadow of a renal calculus will give the operator a very fair idea of the position of the calculus, whether in the ureter, pelvis, or far out in a calyx of the cortex, and will aid him in planning his exploration.

Uratic stones, as a rule, cast a poor shadow, phosphatic and oxalate stones a distinct one.

An attempt should always be made, before operation, to diagnose the nature of the stone by considering the characters of the pain, the urine, and the radiogram shadow. As Mr. Fenwick points out, recurrent attacks of colic, abundance of urates in the urine, and no X-ray shadow usually point to a uratic stone, which may pass by the natural channels if energetic diuretic treatment be carried out; nor is it right to insist upon an operation till such has been tried. Operation, if required, will be difficult, and the kidney often found atrophic. On the other hand, fixed lumbar pain, oxalates in the urine, and a sharp shadow in the radiogram point to a fixed oxalate stone that will require removal, but removal may be easy and without complications. Finally, widespread pain with irritability of the bladder, alkaline or neutral urine containing muco-pus and phosphates, and a large branched shadow in the radiogram point to phosphatic stones with an infected kidney that will require drainage or even nephrectomy.

The X-ray photographs are, however, not an infallible test for renal calculi, and their interpretation requires great caution and considerable expert knowledge. For instance, foreign bodies in the colon may cause confusion, and such conditions as calcareous lumbar glands, calcareous arteries, calcified cysts, and phleboliths are common, and have been the cause of disappointing operations in the past owing to a too hasty interpretation of a radiographic shadow. On the other hand, uratic calculi may fail to cast a shadow, especially in stout patients. In all cases of doubt it is best to have two radiograms taken

on separate days, the bowels being emptied by a smart purge during the interval between the two exposures.

In cases of doubt control experiments may be made, placing stones of known composition beneath the patient. A radiogram taken after the passage of ureteric bougies impregnated with iron oxide will also prove of service.

Tumours or abscesses of the kidney often cast a faint shadow that can hardly be mistaken for that of a calculus. The screen method has lately had some warm advocates, but in our hands it has not proved nearly so satisfactory as the radiographic plate.

On the other hand, cases undoubtedly occur from time to time in which repeated radiography fails to detect quite a large stone, which is afterwards found at operation; but latterly these cases have been very few in number. The absence of an X-ray shadow should not, therefore, deter the surgeon from operating in the presence of well-marked signs suggesting a calculus. Even if a calculus is not found, usually some other cause for the symptoms is discovered at the operation and remedied.

The indications for the operation are as follows :—

(1) Presumptive evidence of stone, the chief being the characteristic pains, attacks of hæmaturia, and radiographic evidence, after a fair trial in uric acid cases of medicinal treatment.

(2) Secondary or primary infective changes in the kidney.

(3) Calculous anuria, which usually entails a primary nephrotomy followed by a secondary nephrolithotomy.

Instruments Required.—In addition to those required for the exposure of the kidney (page 487) the following special instruments are needed: a small bladder sound; a ureteric bougie; stout probes; scoops; lithotomy forceps; gall-stone forceps; Lister's sinus forceps; a small periosteal elevator; sharp-pointed and blunt-pointed curved bistouries; Halsted's needle-holder; the finest curved reversed Hagedorn needles.

The preparation of the patient, the position, and the steps of the operation down to the exposure of the kidney have been described above (page 488).

Detection and Removal of the Stone.—From consideration of the radiogram the surgeon will already have a notion of the approximate position of the stone, its composition, and the number present. He proceeds to clear both surfaces and poles of the kidney, the pelvis, and upper end of the ureter from the perirenal fat, but takes care not to make any attempt at this stage to reduce the kidney out on to the surface, as in many cases stones are easily removed without this step. By means of the finger he carries out a systematic palpation of the kidney, first exploring the pelvis and ureter, then passing his finger over both surfaces of the kidney, pressing the organ at the same time against the muscles of the back or against another finger placed on the opposite surface.

The feel of a stone embedded in the kidney substance can only be learnt by experience. It has been compared to the feel of the uncut end of a pencil. It is often very difficult, if not impossible, to feel a small stone deeply embedded in the renal substance. If the stone is felt at this stage either in the pelvis or directly beneath a thinned patch of cortex, it is extracted if possible with the kidney *in situ*. The kidney is steadied, and an incision is made directly on to the stone. The stone is gently enucleated with the finger, caught between the finger and a scoop, and brought out of the wound, if possible unbroken. The surgeon then satisfies himself that there are no more stones by palpation and by the passage of a bougie down the ureter, and closes the small wound in the cortex or pelvis with a few catgut sutures. This can be very easily accomplished by means of Halsted's needle-holder and fine curved needles. It may, however, be found impossible to extract the stone without reduction of the kidney, or the stone may not be felt. The kidney is then reduced through the wound on to the loin with as much gentleness as possible. The object of the operator is to explore the interior of the pelvis and the calyces, for most calculi are embedded either within the pelvis, or in a calyx that is hollowed out to contain the stone, which is restrained from dropping into the pelvis by the narrow neck at the junction

of calyx and pelvis. The kidney substance is often thinned out over the stone, with the formation of a cyst or abscess.

Three methods may be used to discover and remove the stone.

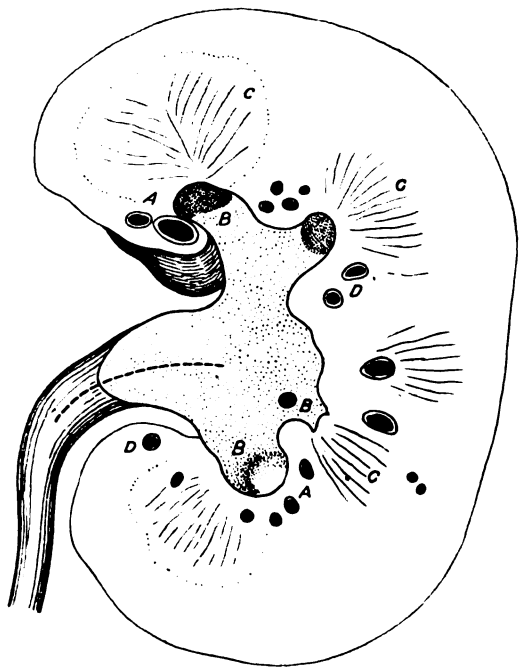


FIG. 137.—VERTICAL SECTION THROUGH THE LONG AXIS OF KIDNEY. (*From a specimen in the London Hospital Museum.*)

The dotted line passing through the upper end of the ureter and into the pelvis indicates the best incision for reaching calculi in the latter or in one of the calyces (B). A section through the convexity of the cortex is seen to divide a number of arteries and veins of considerable size. A, D, Columns of Bertin and large vessels cut across; C, Pyramids of Malpighi.

(1) Pyelolithotomy.

(2) Nephrolithotomy.

(3) Needling.

(1) **Pyelolithotomy.**—The position of the renal vessels having been determined by palpation and inspection, an incision is made through the anterior or posterior wall of the pelvis (Fig. 137, dotted line) long enough to admit the finger, in a direction which

radiates from the ureter towards the hilum. It may be found necessary to encroach upon the renal tissue, in which case the wound should radiate from the hilum parallel with the main vessels. It should not be forgotten that a branch of the renal artery runs behind the pelvis, and care should be taken to avoid cutting this. Such an opening is well adapted for exploring the whole of the pelvis with finger or sound. The finger is inserted and explores from above downwards the interior of the pelvis and the mouths of the calyces, usually ten to twelve in number. A small child's bladder sound can be used instead of the finger. The stone having been found and removed, and the ureter sounded, the wound in the pelvis is closed by a row of fine catgut sutures. If catgut is used there is no fear of subsequent stone formation round the stitches, and there is no need to insert Lembert's type of suture, but the stitch may pick up all the layers of the pelvic wall. Suture of the pelvic wound will save time in the healing, but it is a matter of experience that longitudinal wounds of the pelvis heal up very quickly without suture if the ureter is not blocked, and the wound be drained freely. Fine Pagenstecher sutures may be used, applied after Lembert's method, if very fine suture material be desired, but silk is best avoided. We have seen cases where it has led to the formation of fresh stones containing the sutures as nuclei.

(2) **Nephrolithotomy.**—If the stone cannot be felt in the pelvis or ureter, or if it is well felt just beneath the cortex at one spot, or if it is very large and fixed, then it is better to enter the pelvis by an incision through the cortex, as it is usually easier to extract a large stone fixed in a dilated calyx by that method.

The old method was to slice the kidney from end to end through the prominent convex margin, which often led to profuse hæmorrhage. To prevent this the blood-vessels in the pedicle of the kidney were controlled either by temporary ligature, by clamps such as that of Cumston, or by the pressure of the fingers of an assistant. Bradford's experiments have demonstrated how serious is the damage done to the kidney by such

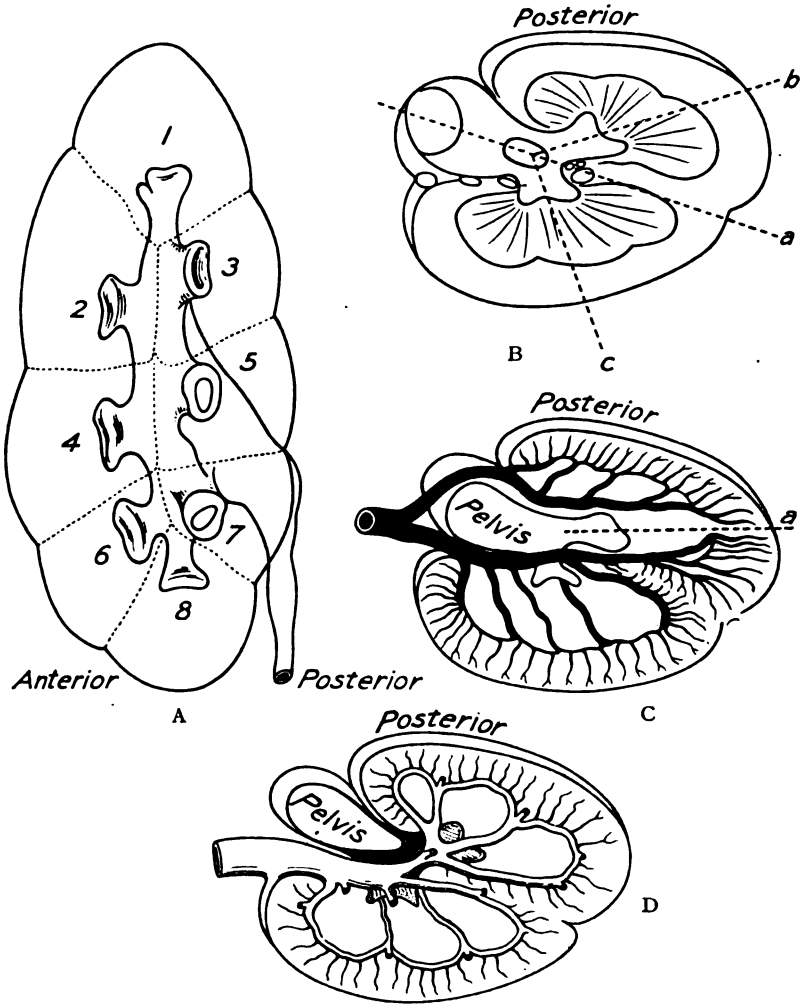


FIG. 138.—ANATOMY OF THE KIDNEY AND THE DISTRIBUTION OF ITS VESSELS.
(*After Max Brödel.*)

A, Lateral view of kidney (made transparent) to show the eight divisions of the renal pelvis: 1, Superior; 8, Inferior; 2, 4, 6, Anterior group; 3, 5, 7, Posterior group. The corresponding division into lobules on the surface of the kidney is faintly indicated by dotted lines.

B, Transverse section through kidney and pelvis to show the division of the pelvis into anterior and posterior divisions, and the arrangement of the papillæ and pyramids: *a*, Axis of pelvis; *b* and *c*, Axis of calyces.

C, Transverse section of kidney to show the distribution of the renal artery. The anterior division of the artery supplies about three-fourths of the kidney substance. The posterior division supplies only one-fourth. *a*, Line to indicate the plane of arterial division.

D, Transverse section to show the arrangement of the renal veins. Unlike the arteries, their distribution corresponds to each pyramid. Those of the posterior pyramid collect into a plexus surrounding the neck of the posterior calyx, from which a trunk runs forwards to join the collecting trunk of the anterior set.

manipulations, and it should now be possible to dispense with such methods in the light of the work of Max Brödel (*Johns Hopkins Bulletin*, January, 1901, No. 118, page 10). He has worked out the arrangement of the vessels inside the kidney, and has defined a "bloodless line" through which it is possible to incise the kidney cortex without severing any large vessel. This line is shown in the diagram (Fig. 139, E) copied from his paper. A sharp-pointed curved bistoury is entered through the lower pole of the kidney in this line, and is made to strike the lower posterior calyx. A blunt-pointed bistoury is then substituted, which is worked upwards into the higher posterior calyces and is brought out on to the surface through the bloodless line (*see* Fig. 139).

The incision should only be long enough at first to admit one finger or a sound for exploratory purposes, and should be enlarged later if necessary for purposes of extraction. This incision should be practised on the dead subject, and is a real advance in the art of surgery.

(3) **Needling.** — The method of needling the kidney for stone "should be abandoned" (Morris). It is now hardly ever required, as the surgeon is generally certain of the presence of a stone from X-ray evidence, and does not therefore hesitate to incise the kidney or pelvis freely in his search, which is almost certain to be rewarded.

If it has been found impossible to detect by the above methods a small calculus, whose presence is indicated by the X-rays— and such a stone may not be apparent to the finger even when the kidney has been removed and is examined upon the table— then the exploring needle may be used as a last resort. It is driven systematically into the substance of the kidney from many points. Twelve or more of such exploratory punctures may be made. While the needle is being used, the kidney must be fixed firmly in the wound. The instrument, which should not be more than two and a half inches in length, is best introduced from one end to the other of the posterior border, and each thrust should be inwards towards the hilum. The

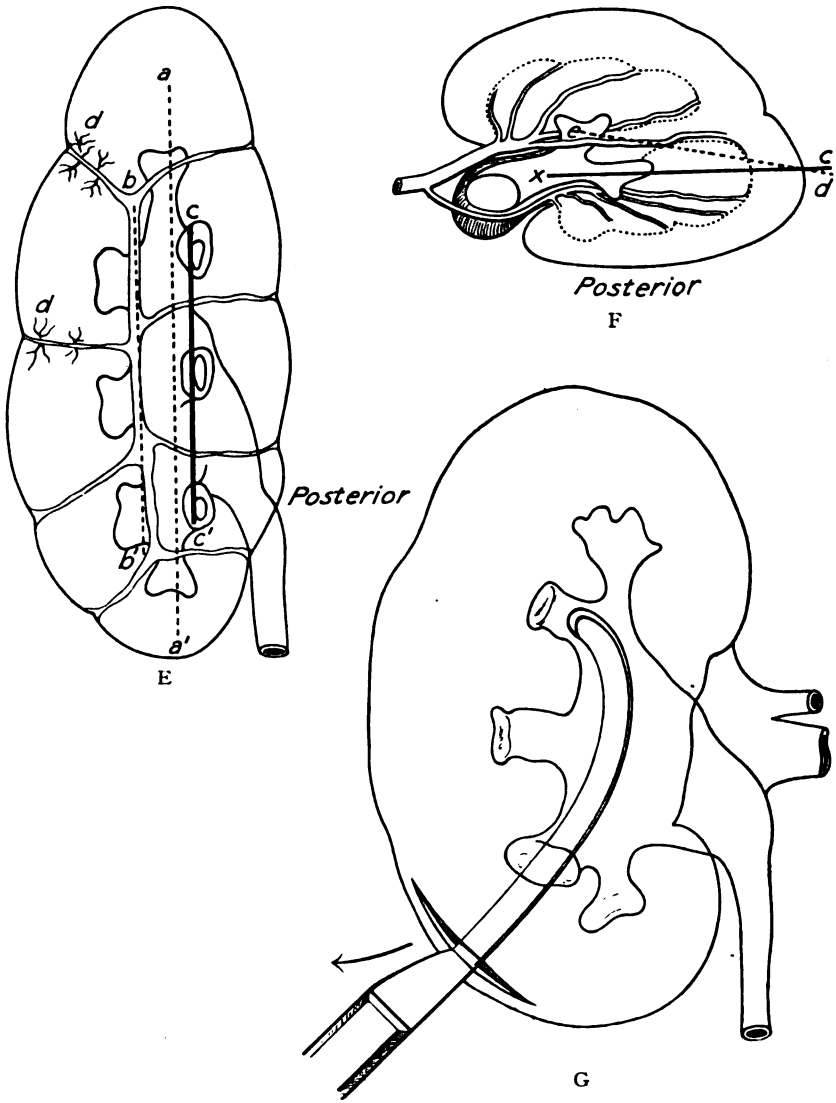


FIG. 139.—OPERATIONS ON THE KIDNEYS. (*After Max Brödel.*)

E, Lateral view of kidney. The surface lines of the lobes corresponding to each calyx are marked. The stellate veins come to the surface along these lines (*d*). The calyces and pelvis are shown. *a a'*, Lateral convex border of kidney; *b b'*, An incision through this line into the pelvis would cut the anterior artery (*see* Fig. 138, C); *c c'*, The bloodless line of incision (*see* Fig. 138, C and D). This incision only cuts one venous arcade.

F, Transverse section to show *c*, *x*, Correct direction of incision so as to strike the front part of the posterior calyx; *d e*, Incorrect direction, which opens the anterior calyx and cuts a large artery.

G, Posterior view of kidney to show method of inserting curved bistoury into the three posterior calyces and then cutting out on to the surface along the bloodless line (*see* F, *c x*).

length of the needle will scarcely allow of the renal vessels being reached. It should, however, be noted that this method is not without danger, and it should only be used as a last resort, when the surgeon has completely failed to detect the stone by other methods.

With regard to the *removal* of the stone, a pair of small lithotomy forceps, or a scoop aided by the surgeon's finger, will answer best. "With a scoóping movement of the finger, introduced through the incision, the stone, unless a branched or very large one, can be raised to the surface of the parietal wound on the point of the finger, or a pair of forceps introduced into the kidney by the side of the finger, and the stone seized and withdrawn" (Morris).

The object of the surgeon should be to remove, if possible, the calculus without breaking it, and with the infliction of the minimum amount of injury to the pelvis or renal substance. If, however, the stone be large and irregularly branched, it may be found necessary to break it up into two or more fragments, and to remove them separately, so as to avoid undue laceration of the kidney. Such a removal should be followed by a free irrigation of the part with warm sterilised water.

When the stone has not set up infective inflammation in the kidney, the wound in the cortex should be closed completely—a step which also checks the hæmorrhage. Catgut should be used for this purpose; never silk, which may lead to the formation of fresh stones. If interrupted stitches are used they tend to cut out and lacerate the kidney. As Brödel insists, Halsted's mattress sutures should be used applied with a straight needle run boldly and deeply through the kidney from back to front and back again with a bight of at least an inch. They should not be pulled too tight, though with such a bight there is no fear of strangulation of the vessels and consequent infarction. Sutures applied in this manner cannot tear out, as they get a purchase on the radiating fibrous bands and blood-vessels running out from the pelvis to the surface of the kidney. If the kidney is infected, drainage is

necessary. An indiarubber tube is passed into the pelvis through the incision, and the rest of the wound with kidney stitched up around it. If bleeding continues and does not yield to hot sponge pressure, gauze can be packed around the tube, but it is apt to irritate the kidney, and its use should be avoided whenever possible.

Before closing the wound in the pelvis or kidney a ureteric bougie *must always* be passed down the ureter into the bladder. It is inexcusable to remove a stone from the kidney and leave one in the ureter.

If this cannot be effected through the wound in the cortex, another small opening should be made in the pelvis, which can afterwards be closed with a single stitch.

A stone in the upper end of the ureter can often be pushed back into the pelvis and extracted.

The advantages of incision of the pelvis are that there is little hæmorrhage and no injury to the renal parenchyma. The great disadvantage is that stones in the calyces cannot often be removed by this method. Incision of the pelvis heals readily in uncomplicated cases.

The advantage of nephrolithotomy is that all stones can be readily removed in this way. The danger of hæmorrhage need not be considered if the incision is properly planned. It is better for the operator to be proficient in both methods, to reserve pyelolithotomy for stones clearly in the pelvis and upper ureter, and nephrolithotomy for stones buried in the calyces or cortex. Both methods will often have to be used in the same case, but undoubtedly incision of the pelvis is now the method of preference, if suitable to the case.*

Drainage.—If the urine contains no pus, and is sterile—facts to be ascertained previous to the operation—as in most cases of oxalate stones, and in many of uratic stones and single calcium phosphate deposits, then it is far safer to close up the kidney and pelvis altogether, and to drain only the postrenal

* J. Hutchinson, Jun., *Brit. Med. Journ.*, Oct. 19th, 1901, "On Certain Points in the Operative Treatment of Renal Calculus."

space. If, however, there is evidence of chronic pyelitis, and especially when there are multiple dendritic phosphatic calculi, then it is imperative to make arrangements for draining and washing out the pelvis by stitching an indiarubber tube into the opening already made.

The question of immediate nephrectomy may arise in the course of the operation. This should never be considered unless the existence, condition, and power of the opposite kidney are known, and have been considered beforehand. It is especially in cases with evidence of pyelitis, the urine loaded with phosphates, and the X-ray shadow large, branched, and filling up the pelvis of one kidney, that the question should have been clearly worked out before proceeding to the operation, and leave obtained from the patient to sacrifice the organ if it is found disorganised with suppuration. Failing this, it is imperative to drain the kidney for a time pending the consideration of a secondary nephrectomy. When the stone smells offensively, it is an indication for nephrectomy; when it does not do so, drainage should be tried. Papilloma of the renal pelvis secondary to stone is malignant and means nephrectomy.

In certain cases the upper end of the ureter will be found securely plugged by a single uratic stone, and the kidney very small and completely atrophied, rather than hydronephrotic. If it is certain that the ureter has been blocked for more than a year, it is wiser to remove the kidney as well as the stone, as re-growth is no longer possible, and the kidney relic is very likely to cause fresh trouble if not excised.

With the rapidly increasing power of early diagnosis of calculus, the nephrectomies and nephrostomies required for such a condition grow yearly less and less in number.

After-treatment.—This differs in no way from that described under the operation for exposure of the kidney, unless a tube has been left in to drain the pelvis. Efforts may be made to wash out the pelvis and ureter daily through this tube. There is risk of a permanent fistula if it be left in the wound too long. After two to three weeks very little additional benefit can be

hoped for by retaining it, and it had then better be removed and the wound allowed to heal if it will.

Difficulties and Dangers.—The chief dangers that have to be guarded against are hæmorrhage, wounds of the pleura, anuria, cellulitis, fistula, and lumbar hernia.

Difficulties may arise from the stoutness of the patient, or the small width of the subcostal angle, or from a highly placed kidney.

Dense perinephritic adhesions, the result of inflammation, are, however, the greatest difficulty. A kidney in which calculi have lasted many years may have degenerated into a mere shell of fibrous tissue blended inseparably with the surrounding fat. In such a case it may be quite impossible to recognise either pelvis or renal tissue, and the surgeon's sole guide is the position of the stones as shown by the skiagraph.

Detection of the Stone.—The great advantage of determining the position of the stone or stones by skiagraphy may once again be urged. With its aid the surgeon no longer works in the dark; he can seldom fail to find the calculus, nor, having removed one, is he likely to leave others behind.

It is possible to examine the exposed kidney on the operating table with the fluoroscope, if adequate preparations can be made at the time. This method is best reserved for those exceptional cases where the surgeon fails to find a stone, though he knows it is present, and has had to close the wound fruitlessly. A second operation is then undertaken after a suitable screen and apparatus have been got ready.

The calculus may be very difficult to detect, especially if it be of small size, or if it be lodged in a calyx, or if it be fixed in a very indurated kidney. The kidney often becomes hard and tough under the continued irritation of a stone, and this very hardness of the renal substance should raise suspicion. The kidney may be sacculated, and into one of the sacculi a small stone may fall, and be difficult to find. The stone may be lost in the rush of fluid which escapes when the pelvis of a much distended kidney is opened.

Mr. Morris draws attention (*Brit. Med. Journ.*, Nov. 16th, 1889) to the following difficulties that may stand in the way of a ready detection of the stone :—

Deposits of tubercle, or even small abscesses, just beneath the renal surface may, from their hardness or outline, give the same tactile sensation as a calculus.

In sacculated kidneys the renal cavity may be wholly or partially filled by a soft mortary phosphatic calculus, which gives no sound nor resistance to the scalpel or needle.

"There is a condition of impaction which absolutely baffles detection," writes Mr. Morris, "unless by chance the stone is struck on probing the kidney. This is when the calculus is fixed in a recess of the kidney of normal size and consistence, with a thick layer of renal tissue all around it."

Removal of the Stone.—The hæmorrhage from the wound in the kidney may be severe.

When the kidney tissue has suppurated, and the calculus lies in the abscess sac, the operation is usually easy, and the situation of the abscess more or less readily indicated. Difficulty in removing the stone may depend upon a very mobile kidney which is hard to fix, upon the stone being very small or very large, and especially upon the calculus being branched. Very special difficulties will nearly always attend the attempt to remove a large branched calculus embedded in the calyces or near the outlet of the pelvis.

Multiple calculi may give rise to difficulty, as may also a stone situated in the anterior part of the kidney near the entrance of the blood-vessels.

Soft calculi, which break up readily are also very difficult to deal with efficiently.

Results.—The results of nephrolithotomy have been remarkably good in cases in which the kidney has been otherwise healthy. Newman has collected forty-two examples of such operations without a death. Where suppuration was present, sixty operations were followed by twenty-six deaths, a mortality of over 43 per cent.

Mr. Henry Morris ("Surgical Diseases of the Kidney and Ureter") gives much larger statistics with very favourable results.

THE ABDOMINO-LUMBAR OPERATION

This method, as the name to some extent implies, involves the exposure of the kidney through an incision in the anterior abdominal parietes, and the subsequent removal of the calculus through the ordinary lumbar wound. The operation has little to commend it, and is now only of interest historically. It is therefore unnecessary to describe it. Anyone interested in the history of the subject can refer to earlier editions of this work.

3.—NEPHROTOMY. NEPHROTRESIS

NEPHROTOMY

Nephrotomy is the term applied to the exposure of the kidney with simple incision of its capsule or cortex.

Nephrotresis is applied to an operation which aims at establishing a permanent urinary flow from the kidney through an opening in the loin.

Nephrotomy is indicated in dealing with the following conditions:—

(1) In cases of hydronephrosis or pyonephrosis for drainage and as a preliminary to nephrectomy.

(2) In certain cases of pyonephrosis in which drainage is required, and nephrectomy is not indicated.

(3) In cases of pyelonephritis caused by the colon bacillus, which fail to react to medicinal and vaccine treatment, for purposes of drainage.

(4) In cases of calculous anuria to establish the urinary flow through the loin.

(5) In some cases of calculous pyelitis or pyonephrosis.

(6) In some cases of acute nephritis with the object of incising the true capsule and relieving intracapsular tension. This may be followed by decapsulation.

(7) In cases of hydatid cyst.

(8) In cases of urinary fistula into some unnatural cavity or part, in order to help the fistulous track to close.

The operation is carried out in the manner already indicated in describing exposure of the kidney (page 488) and nephrolithotomy.

The general circumstances of the operation, the position of the patient on the table, the instruments required and the after-treatment, are all considered in the section referred to.

In Cases of Suppuration.—In some cases of suppuration the presence of redness and swelling may indicate a deviation from the usual incision. In such instances the tissues between the skin and the kidney will be more or less matted together, and may, indeed, form little more than the wall of an abscess.

When the presence of pus is less distinctly indicated the kidney is exposed in due course, and is examined for evidence of abscess. At any suspicious spot a pair of fine sinus forceps may be introduced into the kidney and the blades slightly separated, to be followed, if pus escapes, by an incision into the abscess cavity.

Thick or caseous pus may be evacuated by the scoop. In any case, the interior of the abscess should be explored by the finger. This examination may reveal other abscess cavities or pockets of pus, or may demonstrate the presence of an encysted calculus.

In all cases where pus is found, an attempt should be made to obtain an uncontaminated specimen in a sterilised test-tube or flask for bacteriological investigation, so that there may be a sound basis for vaccine treatment if it is required later in the course of the case. We consider this an essential step nowadays in dealing with any purulent or infective condition of a tissue.

After evacuation of the pus and the exploration of the cavity, the kidney should be well flushed out with warm sterilised water ; a drainage tube is then introduced up to the kidney. This may be packed round with a long gauze strip, and the parietal wound is closed around the tube.

In cases in which the kidney is found to be very mobile,

the organ must be steadied while the abscess cavity is being dealt with; and before the tube is inserted it may be desirable to secure the too movable gland in place (*see* Nephropexy, page 535).

The after-treatment of these cases differs in no essential from that indicated above (page 493). The tube should be shortened gradually, the dressings frequently changed, and the wound cavity frequently and freely irrigated.

In Cases of Simple Cyst.—The kidney, having been exposed, is steadied and examined. A portion of the cyst-wall is denuded of the fatty tissue which covers it, and in some instances the wall so exposed may be brought to the surface and sutured there after having been opened. The opening is made with the scalpel or tenotome, and may then be conveniently enlarged with Lister's sinus forceps. As the contents escape, the cyst-wall is grasped with pressure forceps, and is drawn towards the surface. If it cannot be sutured directly to the skin, it may be secured by four or five points of thin catgut suture to the tissues lower down in the depths of the wound. This precaution is wise when the kidney is unduly mobile. When it is firmly fixed in the loin by adhesions, it will suffice merely to open the cyst freely. In any case, the interior of the cyst should be explored by the fore-finger. A large drainage tube is introduced and the parietal wound is closed around it. The after-treatment of the wound will follow the lines already indicated.

In Cases of Hydatid Cyst.—These cysts possess two capsules, an outer capsule formed by new fibrous tissue in the substance of the kidney, and an inner capsule, the glistening white chitinous envelope of the parasite itself. The surgeon exposes the kidney and scratches through the kidney substance until he has exposed the white inner capsule. He then plunges a trocar and cannula into the cyst and draws off into a sterilised receiver the contents of the cyst, thus causing the cyst-wall to collapse, in doing which it peels itself away from the outer fibrous sheath, aided, if necessary, by stripping with the finger. The complete cyst can then be lifted out of the wound and removed, leaving a large cavity

lined by fibrous tissue. Having assured himself that no more cysts are present, the surgeon deals with this cavity, by inserting purse-string catgut sutures round the walls and drawing them tight, so as completely to obliterate the cavity. Unless this is done, the cavity fills up with serum and blood-clot, which will become infected sooner or later and lead to suppuration. In cases where this method is impossible, and in cases of suppuration in the cyst, a large drainage tube is inserted, and the rest of the wound closed. The cavity then heals slowly from the bottom by the formation of granulation tissue, the tube being shortened as required and finally removed.

In Cases of Calculous Anuria.—Nephrotomy should be performed without delay on the kidney latest affected, and temporary drainage set up. When for any reason this cannot be determined, both kidneys should be exposed and drained. This can be conveniently done with the patient lying on his face, a pillow being placed under the abdomen (*see* page 494).

If it is possible to remove the stone at the same time without adding more than a few minutes to the length of the operation, this should be done; but no prolonged search must be made for the stone, which can be removed with greater safety at a second operation when the kidneys have started work again. The search increases the shock, and leads to a further fall in blood pressure which the kidneys are in no condition to stand.

The opening into the pelvis can be made either direct or through the cortex, and a tube passed down to, but not through, the opening, and the wound closed. Measures likely to stimulate the flow of urine are then adopted (*see* page 493).

Nephrotomy, especially incision through the outer border of the kidney down to the pelvis, has been extensively performed in cases where the symptoms of renal stone have been present, yet no calculi have been found during the operation. A series of such cases will be found in the Middlesex Hospital Reports and in Mr. Morris's work. Sometimes the pain and other symptoms have been relieved by the operation, but as a rule

they return, and the proceeding is not without risk. Serious hæmorrhage during or after the operation has even necessitated nephrectomy. This should not occur if the incision has been made through the " bloodless " line, and it can be stopped by suturing the wound in the kidney as described under Nephrolithotomy (page 506).

Puncturing the Kidney.—The kidney has been punctured with a trocar or aspirator for the relief of hydronephrosis and pyonephrosis, large isolated serous or blood cysts of the substance of the kidney, and hydatid cysts. The safety of deliberate exploratory incision under the modern conditions of surgery has reduced this procedure to the category of unjustifiable methods. The risks are far greater than those of exploratory incision, and cannot be of the slightest avail in curing any of these conditions. It is useless, therefore, any longer to continue to describe this procedure, as it should never be required. The method is referred to merely to warn against it.

NEPHROTRESIS

This term is applied to an operation designed to make a permanent opening from the renal pelvis or cortex on to the skin. It is indicated in certain cases when it is desired to cure a urinary fistula lower down in the urinary tract, and in cases of hydronephrosis or pyonephrosis caused by an obstruction to the ureter which cannot be removed, though ureterotresis would in most cases be preferred or uretero-vesical grafting. The kidney having been exposed, an incision is made through the cortex into the pelvis through the bloodless line, large enough to admit the finger, the true capsule is stripped off the kidney for a short distance on each side of the incision. Stitches are inserted through the capsule and through the cut edges of the wound in the parietes. By this means the cortex is brought up to a level with the skin, and the kidney fixed in that position. A tube is inserted through the opening into the pelvis of the kidney, and another into the perirenal space, and the wound closed. The tubes are removed on the fourth day and the

wound heals, with the exception of a small hole through which urine continues to escape. It is well that some receptacle for the discharge from the loin should be employed.

4.—Nephrectomy

This term is applied to the operation of removing or excising the kidney. It may be partial or complete; primary or secondary to nephrotomy and nephrolithotomy; pericapsular or subcapsular. If the ureter also is diseased, it is removed as well, when the term nephro-ureterectomy should more strictly be applied to the operation. The kidney is such a vital organ that nephrectomy should never be considered except in two classes of cases—first, when life is threatened by the presence of the diseased kidney; secondly, when practically the whole of the excretory tissue of one kidney has been destroyed by disease which all other measures have failed to relieve.

Indications.—A. *When life is threatened by the presence of the diseased kidneys.*

(1) Primary malignant disease of the kidney, including the rare papilloma of the renal pelvis secondary to stone.

(2) Disorganisation of the kidney by injury, when suture is impossible or hæmorrhage uncontrollable.

(3) Early tuberculosis, confined to one kidney and ureter, as natural cure is unknown.

(4) Disorganisation of one kidney by tuberculosis, if it is certain that the other organ is able to carry on the total urinary excretion. In bilateral tuberculosis, the larger kidney often contains the greater amount of healthy excreting tissue.

(5) Rare cases of aneurysm of the renal artery.

B. *When practically the whole of the excretory tissue of one kidney has been destroyed by disease which all other measures have failed to relieve.*

(1) Renal calculus leading to complete atrophy, or hydronephrosis.

(2) Hydronephrosis or pyonephrosis, when the wall is formed by a mere shell of fibrous tissue.

(3) Incurable renal or ureteric fistula if the other kidney is healthy.

(4) Congenital cystic kidney, giving rise to persistent unilateral hæmaturia which is dangerous to life, or having become the seat of multiple abscesses.

It is unjustifiable to resort to nephrectomy until a determined effort has been made to demonstrate—first, the existence of a second kidney; secondly, its power to carry out alone the renal functions for the body; thirdly, if it is healthy or diseased.

Congenital absence of one kidney may be expected in about 1 in 4,000 cases, but complete atrophy of one kidney from disease in early life is far more common than this, judging by post-mortem room experience.

There are certain inherent difficulties in the problem, as it is found, first, that disease in one organ depresses the function of the opposite healthy organ; secondly, the influence of mental nervous conditions upon the quality of the urine is very hard to eliminate—for instance, dread of operation or the passage of a catheter may lead either to complete cessation of renal secretion or to the copious secretion of pale urine of low specific gravity from one or both kidneys. But it is found that by employing many different methods and comparing the results, and by controlling the results by second examinations, a very fair idea can be obtained—first, as to the total renal function; secondly, as to the function of each kidney; thirdly, as to whether the patient will survive nephrectomy.

The following is a short summary of the **chief methods to employ**:—

(1) *To prove the existence of two kidneys.*

Ureteric catheterisation.

Luys' segregator.

The passage of iron oxide ureteric bougies up to the pelvis of each kidney, followed by the fluoroscope or radiography.

The first two methods might do for practical purposes, but they would have failed in the case (mentioned on page 485) where there was one kidney with two normal ureters. The last

method alone could have shown the true condition of affairs. The presence of other congenital sports in other parts of the body, such as hare-lip and club-foot, should make the surgeon extremely watchful.

Exposure or palpation of the kidneys either by opening the peritoneal cavity, or, better, by exposing each kidney from behind. In all cases of doubt the surgeon should never hesitate to explore both kidneys by separate lumbar incisions rather than expose the patient to the risks of anuria.

(2) *To prove the adequate capacity of both kidneys together.*

Investigation of the total daily amount of urine, its physical, chemical, bacteriological, and microscopic characters, qualitative and quantitative.

Comparison of the salt contents of the blood and urine by means of the cryoscope, Wright's method, measurement of electrical resistances.

Estimation of the power to excrete indigo carmine or methylene blue and its chromagen after a subcutaneous injection.

Estimation of the power to excrete sugar after subcutaneous injection of phloridzin.

Artificial polyuria (Albarran).

(3) *To estimate the functional capacity of each kidney separately.*

Separate and collect the urine from each kidney by means of ureteric catheters, the segregator, or even by nephrotomy or ureterotomy.

Apply the methods mentioned under (2) to the collected urines and to the blood.

Lumbar nephrotomy on each side, with incision into the renal cortex if necessary.

As regards these methods the segregator is the easiest, but it often fails, and the instrument as at present made sometimes jambs with the diaphragm raised. So far we have not known this happen with the instrument in the bladder, but it would be an unpleasant accident. The instrument has its chief value when it is wished to estimate the excretion of methylene blue or phloridzin sugar from each kidney.

The ureteric catheter is more difficult to introduce, but the results are far more certain and reliable. The chief danger is that of infecting a healthy ureter. This can be avoided by sterilising the catheter, and by catheterising only the ureter already suspected of disease in cases of unilateral infection. We prefer the latter method in the majority of cases.

Nephrectomy may be performed in two ways :—

A.—By incision through the loin—lumbar nephrectomy.

B.—By incision through the anterior abdominal parietes—abdominal nephrectomy.

Comparative Value of Lumbar and Abdominal Nephrectomy.—*Lumbar Nephrectomy.—Advantages:* Above all, the peritoneum is not opened, which diminishes the risk of the operation from infection of the peritoneum with pyogenic organisms, the tubercle bacillus, or the cells of a new growth. The kidney as an extraperitoneal organ should, if possible, be approached from without the peritoneal cavity. The risks are less of hernia, of shock, and of damage to the colon. If putrid pus escape, the area infected is comparatively small. Excellent drainage is easily provided. Finally, nephrectomy is often preceded by nephrotomy, which should in the vast majority of cases be lumbar nephrotomy (*see* page 488).

Disadvantages: The operation is not well adapted for large *solid* tumours. The wound is small, but this difficulty can easily be met by modifications of the incisions (*see* pages 494, 520). The pedicle is less easily reached, and less easy to be secured with safety. The kidney is more likely to be torn in the act of removal. The operation is difficult in the corpulent, and the kidney is perhaps less easily found.

Abdominal Nephrectomy.—Advantages: Ample room is provided, and the kidney is more readily found. The pedicle is easily reached and easily dealt with. The *existence* of the opposite kidney can be determined. Tumours of any size can be removed.

Disadvantages: The peritoneum is opened. There is more risk of hernia, shock, and injuries to the colon. A second incision is required in the loin for drainage.

The lumbar method should always be used in the conditions mentioned below. The abdominal or the combined abdomino-lumbar method should be reserved for very large solid tumours, especially in children, and for cases of intraperitoneal rupture of the kidney.

A.—LUMBAR NEPHRECTOMY

Indications for adopting this route :—

(1) Small tumours.

(2) When the loin space is not unduly small.

(3) All infective conditions of the kidney, so as to avoid peritonitis.

(4) All cases of hydronephrosis and pyonephrosis, however large, as these can always be reduced to a manageable size by puncture and drainage after the kidney has been exposed.

Instruments Required.—Scalpels; bistouries; dissecting, artery, and pressure forceps; large pressure or clamp forceps, straight and angular; broad metal rectangular retractors; blunt hooks; stout aneurysm needle on a long handle; pedicle needle; silk, kangaroo-tendon, and catgut ligatures; cautery; head-lamp; Hurry Fenwick's angled clamp for the pedicle; periosteal elevators; bone forceps; trocar and cannula.

The **position** of the patient, and of the operator and his assistants, is the same as has been already described (page 488). The hard pillow under the loin should be used, in order to extend the space between the last rib and the iliac crest.

Exposure and Isolation of the Kidney.—The incision made is the same as has been already described in the account of nephrolithotomy (page 496). Through this incision the kidney is exposed, and through it an organ of normal size may be removed.

When the organ is reached and has been superficially examined, it will usually be found necessary to enlarge the original incision. This may be done in many ways.

The oblique incision may be extended to the full length admitted by the conformation of the individual. This incision

will suffice for all cases in which the lumbar operation is allowable. If a greatly increased lumbar incision is called for, then, in our opinion, the lumbar operation is not permissible.

Morris advises that to the original cut be conjoined a second incision, running vertically downwards from the first, and starting from it about one inch in front of its posterior extremity (Fig. 135, B). This second incision is left until the kidney has been reached and explored, and is made by cutting from within outwards with a blunt-pointed bistoury, guided by the index finger of the left hand. This vertical incision affords increased facility for dealing with the pedicle (page 523). Morris also strongly advises an incision which runs vertically upwards, starting an inch in front of the posterior extremity of the oblique incision. The ligament of Henle is divided from within outwards, and some inches of the twelfth rib are excised, care being taken not to wound the pleura. A large amount of extra room is gained by this manœuvre.

The position of the vertical incision with reference to the original oblique cut may be modified according to circumstances. It may be more convenient that it should start from the centre of the oblique cut, or from its actual posterior extremity.

Other incisions, more or less closely resembling the above, have been advised or carried out.

Some surgeons carry a short transverse incision forwards from the lower end of the oblique one. The actual form of incision is a matter of little moment, provided that sufficient room is obtained and that the peritoneum is not opened. Prof. Kocher, however, advocates as a preliminary measure opening the peritoneum at the lower and front end of the wound sufficiently to enable the surgeon's hand to explore the opposite kidney and to ascertain that it is of normal size. The wound in the peritoneum can then be sutured and the operation proceeded with. This method can only inform as to the existence of the other kidney. It tells nothing as to the condition of the organ, and may add materially to the risk.

König divides the soft parts vertically along the border of

the erector spinæ down to a point just above the iliac crest. He then curves the incision forwards towards the umbilicus, and ends it at the outer border of the rectus muscle (Fig. 135, c). All the muscles are divided down to the peritoneum. The vertical part of the wound is completed first, and the fingers being introduced, the peritoneum is detached and is pushed forwards, so as to be free of the anterior part of the incision when that comes to be made.

This incision — known as the retroperitoneal lumbo-abdominal incision—gives plenty of room, but it is needlessly extensive. It involves a very considerable division of muscular fibre, and is very likely to be followed by a ventral hernia. When any such extensive exposure of the renal region is called for, it is better that the anterior abdominal incision should be employed.

It is understood that the kidney has been exposed in the manner already described (page 491).

It is now necessary to examine it and to separate it from its connections. Good broad rectangular retractors should be used, so as to expose the parts well, and an assistant should at the same time press the kidney into the wound by the hands applied over the front of the abdomen. If there has been no inflammation in the perinephritic tissue, the separation of the kidney is easy.

In performing nephrectomy on the right side, especial care should be taken in drawing the kidney into the wound. The vascular pedicle is very short, and is liable to tear if any force be used; this accident has proved fatal in even experienced hands. The right renal vein is only about an inch long, and the kidney normally is in contact with the vena cava. (*See* Frontispiece.) The latter vessel has sometimes been opened during nephrectomy. This accident most often occurs in cases of sarcoma or tuberculosis.

The fatty tissue around the kidney can readily be detached by means of the index finger of one hand introduced into the depths of the wound, and swept round the organ in close

contact with its capsule. In this manner the gland is readily enucleated and isolated.

Even when no inflammation has occurred, it is possible—as Mr. Morris points out—that some of the renal capsule may be torn off and left behind when this manœuvre is carried out. When there has been much inflammation, as in cases of calculous or tuberculous pyonephrosis, the tissue surrounding the kidney will be found condensed and adherent, and the enucleation of the organ will then be difficult or in some few cases impossible. In such case the kidney should be enucleated from its thickened and firmly adherent capsule, and the latter left behind with the pedicle. In effecting this enucleation, a flat hernia director will be found of service. The only guide in such enucleation is the exposed kidney tissue itself.

It may be possible, in some of these cases, to isolate the kidney, together with its capsule, entire, by means of cutting—scissors curved on the flat being employed for the purpose—but the satisfaction of removing every trace of the disease is hardly sufficient to justify the risk incurred by such a proceeding.

In any instance, the enucleation must be conducted with caution; the capsule may be stripped off in one place, and the adherent tissue cut through in another. The kidney must not be violently torn out; and, indeed, in such cases, but little traction can be brought to bear upon the organ.

When the kidney has been already exposed by a previous operation, it will probably be easier to enucleate the organ from its own capsule than from the perinephritic fatty tissue.

In dealing with malignant tumours, it is well to remove the fatty capsule with the kidney in the hope of extirpating the local extension of the disease. The same holds good for perinephritic inflammations, with the provisoes noted above. If a hydronephrosis or pyonephrosis is being attacked, a trocar and cannula should be plunged into the cavity before enucleation is attempted, and the tumour emptied. The great reduction in size thus effected renders possible the excision of any such tumour through a lumbar incision.

Treatment of the Pedicle.—The kidney, having been freed, is drawn as far out of the wound as possible, and the pedicle is isolated with the fingers and examined carefully. To obtain more room, the lower ribs may be drawn forcibly upwards with a strong retractor.

When convenient, an assistant may draw the kidney forwards while the surgeon deals with the pedicle.

The individual structures in the pedicle should be exposed and isolated as far as possible by rapid dissection. The ureter is well isolated, and secured between two ligatures. The vessels are then secured separately, or in as small bundles as possible, the arteries first and the veins afterwards. Tendon or silk is used to secure the pedicle, and it is conveniently passed by means of a stout aneurysm needle. The ligatures on the vessels should be applied as far away from the kidney as possible.

As each ligature is being drawn tight, all traction upon the pedicle must be taken off.

The pedicle is now divided with blunt-pointed scissors close to the hilum of the kidney.

Before severing the pedicle, some surgeons apply a clamp so as to prevent the cut end from dropping away out of control of the eye. The angled clamp devised by Mr. Hurry Fenwick is the best instrument for the purpose.

The kidney is now removed.

The pedicle is examined. Any bleeding point detected should be at once seized with pressure forceps, and secured later. Such hæmorrhage may depend upon the existence of aberrant or abnormal branches that have escaped the ligatures on the pedicle.

The ureter is now examined. If it appears healthy, it is left as it is, securely ligatured. If it is dilated and occupied with foul or tuberculous pus, then as much of the tube as can should be excised above a catgut ligature applied as low down as possible. Silk should never be used for a tuberculous ureter, as it leads to a persistent sinus. It is well to apply pure carbolic

or the actual cautery to the stump of the cut ureter, as it is infective.

Silk is the most convenient material for the ligature of the vessels of the pedicle, but other substances have been used with success, and notably kangaroo tendon.

The attempt to ligature the artery and the vein separately is in some instances impossible.

The possible existence of abnormal veins and arteries must always be borne in mind. These vessels may escape the clamp or the ligature, and yet be severed when the kidney is removed. In more than one recorded case, fatal hæmorrhage has resulted from this cause.

In the event of bleeding persisting after the kidney has been removed and the pedicle tied, the wound must be well exposed, dried, and illumined. In nearly every instance it will be possible to pick up the bleeding vessel with pressure forceps, and subsequently to tie it. If the hæmorrhage persists, and it is impossible to secure the bleeding point so, the wound must be well plugged from the bottom with gauze, which is kept in place by firm bandaging.

The wound in the parietes is now closed by sutures, as already described (page 492). A drainage tube is introduced if necessary into the depths of the wound, and the part is dressed in the usual way, and is supported by a firm flannel bandage.

Complications of the Operation.—It may be found impossible to remove the kidney after it has been exposed.

This is most likely to occur in cases of malignant disease, and in those of pyonephrosis with extensive adhesions to duodenum, colon, pancreas, vena cava, or liver. With regard to the malignant growths, nephrectomy is of very doubtful value, and hence if the removal of the kidney seems likely to endanger the patient's life, it is better to abandon the attempt. Few operations are so anxious and difficult as the removal of a large suppurating kidney universally adherent, and the wound in such case will require free provision for drainage.

If, when the kidney is exposed through the loin, it is found to be of so great size as to render removal through the lumbar incision doubtful, it is far better to perform the abdominal operation than persist at all hazards in the attempt to extract the organ from the loin.

There is nothing whatever to recommend the advice that in these cases, after the vessels have been secured by a temporary ligature, the kidney should be cut away in separate portions. Such a proceeding is to be condemned.

When the pedicle is very short and thick, and perhaps overlapped by the kidney, clamps with long narrow blades should be applied, and then the kidney itself be cut away well in front of it. The angled clamp devised by Mr. Hurry Fenwick is the most suitable instrument, and will be found far more efficient than straight clamps. After the removal of the diseased organ the stump can be brought into view, the vessels can be secured by separate ligatures conveniently applied, and the stump trimmed by removing as much tissue as the position of the ligatures will allow. If it is impossible to apply ligatures, the clamp can be left on for forty-eight hours, after which time it can safely be removed if gentleness be employed. The patient will have to be watched and kept lying on the opposite side during that time. This method will be found of value in difficult cases of tuberculosis with contracted pedicle.

Should the peritoneum be wounded or torn in removing the kidney, the rent should, if possible, be sewn up with a catgut suture, after wiping out the peritoneum locally with dry sponges on holders.

After-treatment.—The patient must be kept in the recumbent position until healing is complete. The drainage tube may be removed on the second day in most cases, but it is well to retain it considerably longer when the operation has been specially difficult, when an abscess has been encountered, or when from infection of the perirenal tissues some suppuration is certain to occur. The wound usually heals well, although some three or four weeks may elapse before the drainage track is perfectly

closed. The recumbent position should be insisted upon until the healing is firm.

B.—ABDOMINAL NEPHRECTOMY

The list of instruments required has already been given (page 519). The operation is conducted upon the general lines observed in other abdominal operations. The preparation of the patient, and the general disposition of the patient, the surgeon, and his assistants, have been considered in a previous section (page 488 *et seq.*).

The Operation.—The incision is vertical, is made in the semilunar line, is about four inches in length, and is commenced just below the margin of the ribs. The centre of the incision will probably be about the level of the umbilicus. The abdomen is opened, the cut peritoneum on either side is picked up with pressure forceps, and when all bleeding has been checked the hand is introduced.

The following are now the steps of the operation :—

A. Examination of the opposite kidney.
B. Establishment of the coffer dam.
C. Isolation and separation of the kidney.
D. Isolation of the pedicle and demonstration of its component parts.
E. Ligature of the pedicle.
F. Removal of the kidney.
G. Disposal of the ureter.

A. As a first measure the hand is passed across to the opposite side of the body, and the opposite kidney carefully examined. If this organ is found to be extensively diseased, or if it is discovered that the patient has but one kidney, then the nephrectomy must be at once abandoned.

The kidney on the affected side is now examined, its size is estimated, its general characters as regards mobility, consistence, etc., are ascertained, and the condition of its pedicle is demonstrated. By this step the *existence* of a second kidney

can usually be demonstrated, but nothing can be learnt as to the *functional value* of the kidney that can safely be relied upon when the question of nephrectomy is being considered. The method, therefore, is useful for the first purpose, and unobjectionable so long as its limitations be kept in mind. If these are forgotten it often becomes a snare.

The small intestines are kept aside by slightly tilting the body to the opposite side.

The colon is made out, and is pushed towards the median line. The surgeon then incises the outer layer of the meso-colon vertically over the renal region. Into the rent thus made the fingers are introduced, and the kidney is laid bare.

B. Pressure forceps are made to grip the peritoneum on each side of this rent in the meso-colon. The forceps—some six on each side—are then lifted up and lift up the two edges of the peritoneum with them, as one would lift up the mouth of a sac. The margins of the rent in the meso-colon are, indeed, drawn up until they reach the margins of the skin wound. The kidney lies exposed at the bottom of the peritoneal bag thus produced. It is within this bag that the whole operation is carried out, the peritoneum being freely separated, so as to give plenty of room. The operation is thus carried out within a species of coffer dam. If the forceps be properly adjusted, the operation is extraperitoneal. The general peritoneal cavity is shut off. If the kidney contains an abscess and that abscess bursts during removal, it bursts into the coffer dam, and is quite isolated. Any bleeding also is limited by the walls of the coffer dam, and must remain extraperitoneal. We have never found any difficulty in maintaining this coffer dam intact during the whole of the operation. It has the advantage also of preventing any coil of small intestine from appearing in the operation area.

C. As soon as the coffer dam has been made secure, the kidney is exposed, and is well and thoroughly isolated all round. This separation is to a great extent effected by the fingers, which keep throughout very close to the capsule of the gland. Now and then the scissors are needed to divide resisting bands,

and sometimes the scalpel is required. The most difficult part of the kidney to free is the upper end, and that should be dealt with last. Care must be taken to leave the suprarenal body behind. When the kidney is very adherent, this process of separation is very tedious. Free use of the scissors may be demanded. The chief rule is to keep always close to the kidney, and to be careful of the vessels when the hilum is reached. There is no objection to the leaving of parts of the capsule behind, but it should be avoided whenever possible.

D. When the kidney has been well and entirely freed, the next step is to free the pedicle. This must be done by pushing the peritoneum towards the median line. The colic arteries run outwards to the colon closely applied to this portion of the peritoneum, which includes the inner layer of the meso-colon. Ligature of these vessels leads to gangrene of the gut wall, the collateral circulation being so poor. Keeping this fact in mind, the surgeon will be very careful when stripping the peritoneum inwards not to wound these vessels. The pedicle must be isolated on all sides, in front, behind, above, and below. Some dissection will be needed to make this separation complete. The next step in the operation is the isolation of the component parts of the pedicle. This is done when the kidney has been drawn well outside the abdominal wound. The kidney is dragged upon and the pedicle displayed from all sides. The isolation of the ureter and chief vessels is effected by dissection with scalpel and forceps, and with the forceps and the blunt dissector. On the right side the very close position of the vena cava must be borne in mind. Adhesions may render this part of the operation very difficult.

E. The pedicle is now tied in segments. The ureter is first isolated, and is at once severed between two strong catgut ligatures. To the lower ligature a pair of pressure forceps are attached as a guide. The vessels of the pedicle are now tied separately or in small bundles by means of fine silk. The arteries must be secured before the veins. An aneurysm needle is useful at this stage. The tension on the pedicle is relaxed as the

ligatures are drawn tight. Before the pedicle is divided one or more angle clamps may be applied to the pedicle tissues on the proximal side of the ligatures.

F. The pedicle is now cut through with scissors. To prevent an escape of blood from the kidney, the vessels may be clamped on the kidney side of the intended line of section. The kidney is now free, and is removed. The surgeon then returns to the pedicle stump. He removes any clamp forceps which may be in position, and applies additional ligatures if necessary.

G. The surgeon now seeks for the divided ureter. If it be healthy, nothing remains but to cut the ligature on it short, and drop it back. If it be dilated or contain pus, as much of the tube as can be removed should be removed. It should be ligatured, and the cut end exposed beyond the ligature should be very vigorously scraped with a Volkmann's spoon and cauterised. It may be necessary to examine the ureter for a calculus, and to remove such calculus if found. I (F. T.) have met with no instance in which it appeared to be necessary to bring out the divided end of the ureter through an incision in the loin. No circumstances would justify the bringing of the divided end of the ureter out at the anterior abdominal incision. This step leaves a band which may lead later to intestinal obstruction.

The cavity left by the removal of the kidney is well cleaned out, and if any septic matter is likely to have found its way into it, the whole cavity is well washed out with a weak and warm antiseptic solution. When the operator has convinced himself that all oozing has ceased, and that the operation area is absolutely clean, the wound in the parietes may be closed in the usual way, and a suitable dressing applied. No drainage is required.

If, however, any septic matter has escaped into the cavity left by the removal of the kidney, then drainage should be employed. The drainage tube is best carried through the loin at a convenient spot close to the anterior or outer edge of the quadratus lumborum muscle.

There is no need to close by sutures the rent made in the peritoneum. Before closure of the abdominal wound a peritoneal toilet is carried out with dry sponges on holders.

Comment.—In dealing with cysts of the kidney, with cases of pyonephrosis, and with such tumours as are represented by soft sarcomata, it is very important that the capsule of the gland be not opened.

In a case operated on by Czerny, the capsule was broken through, and the soft sarcoma growing within was laid bare. A profuse hæmorrhage ensued, which could only be arrested by temporary compression of the aorta, and which returned as soon as this was taken off. The aorta was finally ligatured. The bleeding ceased, and the patient lived ten hours.

In this operation, when on the right side, the close proximity of the vena cava must be borne in mind. In one case Mr. Thornton accidentally included a small piece of the vena cava in the pressure forceps, which had been applied about the renal vessels. When the vessels were divided, a small **V**-shaped piece was cut out of the wall of the vena cava, and the patient bled to death.

Some cases of wound of the vena cava have, however, recovered after a lateral ligature had been applied. One such case occurred to me (F. T.), and no trouble followed the tying up of the hole as one would tie up a hole in a bag. Bleeding from a wound in the vena cava is very gentle, and during inspiration it practically ceases. During expiration the blood wells up slowly. In one instance in which adhesions about the pedicle were very troublesome, I had to cut a little into the vena cava ; the amount of the great vessel taken up by my ligature caused œdema of the legs for nearly six months. The patient was a middle-aged woman, and the kidney was removed for old tuberculous disease. Beyond the œdema of the legs, no inconvenience whatever followed upon this narrowing of the great vein.

On account of the nearness of the vena cava and the over-

shadowing of the liver, removal of the right kidney is more difficult than removal of the left.

It is always desirable to separate the kidney before the pedicle is dealt with. If the pedicle is torn before complete removal of the kidney and the bleeding cannot be controlled and threatens to prove fatal, a sponge should be thrust firmly against the bleeding part, and the wound enlarged without a moment's hesitation by a horizontal cut outwards three or four inches long through the whole abdominal wall at once. It is surprising with what increased ease the pedicle can be exposed and controlled through such an opening. Such cuts heal more soundly than is generally believed. I (F. T.) have seen life saved by this manœuvre carried out without hesitation.

The rough clamping of the pedicle and the inclusion of it in one heavy ligature is to be condemned. There is no difficulty in isolating the vessels and securing them individually.

The diaphragm has been torn in clearing the upper end of a very adherent kidney.

The parietal wound should be free, and be enlarged as required.

The incision in the meso-colon should be made at least one inch from the bowel. When no meso-colon exists, the incision is made in the parietal peritoneum to the outer side of the colon. In such case the coffer dam is not easily maintained, as the peritoneum is apt to be too scanty. In dealing with infected kidneys it is safer to pack off the wound from the general peritoneal cavity with large gauze-pads or flat sponges before the establishment of the coffer dam.

The **after-treatment** resembles that observed after other abdominal operations. The old fear of exhibiting opium after this operation has now been proved to be unfounded. Experience has taught this, and it is explained by the fact that opium is excreted by the stomach rather than the kidney. It is therefore cruel to withhold it, and the pain is often so intense after this operation as to demand nothing less.

C.—OTHER METHODS

(1) **The Combined Abdomino-lumbar Method.**—Mr. Morris speaks highly of this method for dealing with large tumours surrounded by adhesions. The kidney is exposed by the lumbar route, the posterior surface cleared from its bed, and the diagnosis confirmed or completed. The wound is then plugged, the patient turned over on to his back, and the kidney exposed afresh by the abdominal route. The anterior surface is thus laid bare, the pedicle exposed, the kidney reduced, and the pedicle tied and cut across. By this means the one great difficulty of the anterior operation is evaded—namely, the clearing of the posterior surface of an adherent kidney. This method is one worth remembering in difficult cases.

(2) **By Median Incision.**—The abdomen is opened in the median line, the intestines are pushed well over to the opposite side by means of sponges, and the kidney is exposed. The colon is displaced to the outer side, and the meso-colon is opened through its inner layer. The rest of the operation does not differ materially from that just described.

When compared with the lateral operation, that procedure may claim the following advantages over the method of the median incision :—

In the lateral operation the kidney is more directly exposed, and the pedicle is more easily reached ; the peritoneal cavity is less extensively exposed ; the kidney is reached through the outer layer of the meso-colon, and therefore the main colic vessels are not so much exposed to damage.

The median operation has one trifling advantage—the opposite kidney can be more readily examined.

(3) **By Lateral Extraperitoneal Incision.**—A vertical incision is made from the anterior superior iliac spine up to the eighth rib. The various layers of the parietes are cut through until the peritoneum is reached. This membrane is not incised, but is stripped up from the iliac fossa, and from the anterior surface of the kidney, and is displaced inwards.

The kidney is thus exposed, and the pedicle is dealt with in the usual way.

No advantage can be claimed for this method. The wound is deep, and the risk of ventral hernia is increased. The fact that the peritoneum is not opened is the only point that can be urged in support of the procedure.

Results of Nephrectomy.—In general terms, the mortality attending nephrectomy may be placed at about 15 to 20 per cent.

Death has been due to shock, to hæmorrhage, to uræmia and anuria, to peritonitis, and to the results of septic inflammation.

PARTIAL NEPHRECTOMY

It is quite feasible to excise a portion of the kidney. The bleeding is easily controlled and the wound heals readily. Unfortunately in practice it is seldom that an opportunity occurs of carrying out this procedure, much as the surgeon may desire to sacrifice the part rather than the whole.

The following are the conditions in which it may be indicated if all the circumstances seem favourable:—

(1) Injuries to the kidney.

(2) Cysts.

(3) Chronic abscesses near the surface or at the poles, especially those caused by a calculus.

(4) Small neoplasms, and neoplasm of neighbouring organs such as the suprarenal.

(5) For the cure of fistulæ.

(6) Localised tuberculous deposits in certain carefully selected cases.

The Operation.—The kidney, having been exposed, is drawn out on to the loin. Careful inspection and palpation enable the surgeon to decide whether a partial operation is indicated. His proceedings will differ according to whether he wishes to excise a pole or a portion of the middle of the kidney.

Excision of the Middle Portion of the Kidney.—The bleeding is controlled by digital compression of the renal vessels.

A wedge which contains the whole of the diseased portion is cut, its base being formed by the capsule and cortex, its apex lying near to or, if necessary, encroaching upon the pelvis. If the cut surfaces show signs of disease, fresh slices are cut off until healthy surfaces are seen. These are brought into apposition, and the two portions of kidney are then united by means of mattress sutures of preferably chromicised catgut run boldly through the kidney from front to back and back again. The bight should be about an inch, and if the knot is tied firmly effectual control of the cut blood-vessels is obtained (*see* page 505). Three or four such sutures usually suffice, the first passing near the pelvis, the last near the kidney's convex border. There is no need to stitch the fibrous capsule. Drainage is provided and the wound is closed.

Excision of One or Both Poles.—When dealing with tuberculosis which attacks the poles of the organ before it attacks the intervening portion of the kidney, it may be thought advisable to remove one or both poles rather than the whole kidney.

The bleeding is conveniently controlled by means of Mr. Hurry Fenwick's kidney compressor, or, failing this, by digital compression of the pedicle. The compressor is applied beyond the plane of section, and the pole sliced away.

Any large cut vessels can be seen, picked up, and tied with catgut ligatures. The clamp is removed, and if the bleeding is still profuse it can readily be checked by the passage of a series of catgut mattress sutures passed through and through the kidney about a third of an inch from the cut surface. These should be tied just sufficiently tightly to stop the bleeding. There is seldom any need in these circumstances to use the cautery or to pack with gauze tampons.

At the same time we are strongly of opinion that for tuberculosis of the kidney partial nephrectomy is very rarely adequate, the disease being inevitably progressive unless it is totally eradicated at the operation. If the surgeon is skilful enough to make an early diagnosis while the disease is still confined to one kidney, he will usually prefer to remove the whole organ

unopened, leaving an uninfected wound which will heal straightaway, and to cure the patient. For if he excises one or both poles which show gross tuberculous lesions, he can never feel sure that he is not leaving behind patches of miliary tubercle buried deeply in the cortex, and ready to continue the destruction of the whole organ, and spread to other portions of the body.

On the other hand, where one organ has already been removed, or where both kidneys are affected, if the surgeon decides to interfere at all, his interference will rather take the line of opening abscesses wherever found, scraping out the pyogenic membrane, flushing out the cavities to remove the *débris*, and then closing up the wound without drainage. Nephrotomy with drainage for tuberculosis of the kidney, with its almost inevitable sequence of secondary infection and persistent sinus, should become as much a thing of the past as the old method of leaving a tube in a psoas or lumbar tuberculous abscess.

5. Nephrorraphy. Nephropexy

Preliminary Considerations.—The subject of nephroptosis or movable kidney has of late caused much discussion. On the one side are those who say that the condition occurs in one woman out of every five, that it rarely causes trouble, and is but an accident in a general disorder, and that any treatment if required should consist in the use of supporting apparatus rather than an operation; on the other side are those who affirm that floating kidney is the cause of considerable trouble, both local and general, that it usually requires an operation, which operation will relieve all symptoms in three-fourths of the cases. The truth must lie somewhere between these two extremes.

At the present time few are agreed, first, as to the mechanism by which the moving kidney is supported and restrained in position; secondly, why it becomes unduly movable. Until these two things are determined with certainty, there can be no true principles on which to base an operation.

The question can only be solved in two ways:—

(1) By means of observations as to the movement of the kidney; the ligaments which restrain these movements; the forces which support the kidney when the body is upright; the causes of gross displacement of this organ.

(2) By means of unbiassed observations made upon the subjects of the various types of operations, after a sufficient interval has elapsed since the operation, compared together, and compared at the same time with the results of palliative treatment used alone in another series of cases. In this way a cure might be found for the condition without all the causes being necessarily known.

The following statements appear to us to hold good, and form principles on which to design operative treatment:—

The *weight* of the kidney in healthy individuals is sustained by the intra-abdominal pressure.

The *movements* of the kidney are produced by the opposing actions of the diaphragm and the muscles of the belly wall transmitted through the liver and intestines.

The movements are merely *restrained and kept within due limits* by the perinephric fascia and the peritoneum.

The perinephric fat serves to adapt the kidney to the space in which it moves, reduce friction, prevent jarring, and transmit the intra-abdominal pressure.

The pedicle carries the blood-vessels to the organ, and in health never supports the weight of the kidney.

The condition of nephroptosis is far more common in women than in men, and on the right than on the left side. Any explanation of the condition must therefore be capable of explaining these two facts.

In healthy individuals standing in the upright position the intra-abdominal pressure is positive. This pressure is maintained by the tone of the diaphragm and the muscles of the abdominal wall, especially the transversalis and oblique muscles, contracting on the viscera, which are contained in a closed cavity lined by muscles. In cases of splanchnoptosis this pressure falls and may even become negative.

The forces which support the weight of the kidney in health and cause it to move down and up are as follows:—

(1) The downward force, A (Fig. 140), of the diaphragm acting through the liver.

(2) The force, B, produced by the sloping and unyielding surface of the back wall of the renal fossa.

(3) The force, C, of the contracting transversalis and oblique muscles acting through the intestines, which muscles undergo

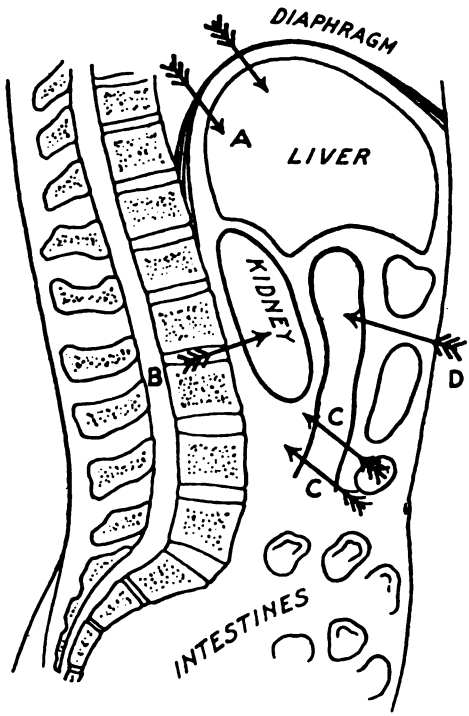


FIG. 140.—DIAGRAM OF FORCES WHICH HELP OR HINDER THE PRODUCTION OF FLOATING KIDNEY. (*For explanation see text.*)

a gradual relaxation of tone during inspiration, and an active increase of tone during expiration.

(4) The force, D, acting from the front through the intestines, the result of the tonic action of the rectus muscles of the belly wall above the umbilicus.

The perinephric fascia is firmly fixed above and on the inner side of the kidney. It does not move at all during respiration, as may be seen at operations. If it did indeed suspend the weight of the

kidney, it would have to move down during inspiration and up during expiration, pulling the kidney with it. It is therefore misleading to call its superior attachment the "suspensory ligament of the kidney," a term which should be given up.

The kidney, on the other hand, is never firmly fixed, nor is it possible to fix it immovably into proper position so long as diaphragmatic breathing is practised. Its movement, in common with that of the other supra-umbilical viscera,* is brought about by the opposing actions of the diaphragm and the muscles of the belly wall, acting on elastic bodies within a closed space. During inspiration the diaphragm pushes these viscera downwards and forwards, a force which is opposed by the tonic action and elasticity of the abdominal muscles, chiefly the oblique and transversalis muscles. During expiration the diaphragm relaxes, and with the viscera is pushed upwards and backwards by the active contraction of the muscles of the belly wall.

In healthy breathers the transversalis muscle is seen to form a groove across the belly at the level of the umbilicus, always present, but best marked during expiration. This marks a line of stress serving to keep the supra-umbilical viscera piled above the infra-umbilical, and preventing incidentally the tendency of the kidney to slip downwards and forwards.

The kidney can therefore only become displaced in three ways :—

(1) The support of the abdominal muscle may fail. The nephroptosis is then part of a general splanchnoptosis.

(2) The closed supra-umbilical intramuscular space may become too small to hold the contained viscera, in the absence of any loss of tone in the belly wall, and of prolapse of the diaphragm. This may arise from increase in size of any of these viscera or from compression of the space from outside. This fact explains how the condition may be found in subjects with good belly walls, and without general splanchnoptosis, the right kidney being the first organ to yield to the stress and be forced down out of this space.

(3) The condition may be congenital.

As Keith has shown, the ligaments which limit the kidney movements are capable of being stretched some two to four inches during health; they therefore oppose very little permanent resistance to displacement when once an adequate cause of displacement arises, and

* Arthur Keith, "The Nature and Anatomy of Glénard's Disease," *Lancet*, 1903, i., 631, 635, 700.

soon become considerably lengthened. This statement does not suggest that the ligaments are incapable of supporting the weight of the kidney; in health they do not do so. If the support of the abdominal muscles be removed, the kidney drops nearly two inches with the body in the upright position, and is now largely held up by the ligaments. But these ligaments are stretched, and in time become permanently lengthened, and are in a state of stress, a condition opposed to comfort and health, as the function of the blood-vessels is interfered with and the nerves are painfully stimulated. The pedicle opposes a stronger resistance and causes the kidney as it sinks downwards to rotate inwards and forwards, but in time the pedicle also becomes greatly lengthened and stretched. It is therefore important to recognise two distinct classes of case :—

(1) True splanchnoptosis, in which the nephroptosis is but a part of the disease, due to relaxation of the belly wall and sinking of the diaphragm.

(2) False or partial splanchnoptosis, in which the right kidney may be the first and only organ to suffer.

Causes of the first group are those which lead to loss of tone in the belly wall, or loss of substance in the supra-umbilical space. These are the natural tendency to splanchnoptosis caused by the assumption of the upright position in man and by the growth of the skeleton, and amongst women by lack of exercise, pregnancy, neurasthenia, and other diseases of nutrition, which are accompanied by loss of muscle tone, loss of subperitoneal fat, and contracted empty intestines.

The causes of the second group are—

(A) Great enlargement of one or more of the supra-umbilical viscera, including the heart and lungs;

(B) Compression of the hypochondriac spaces: the commonest causes being tight, ill-fitting corsets, and prolonged dyspnœa or cough. This accounts for the large number of cases found amongst patients suffering from morbus cordis (24·6 per cent.), and pulmonary tuberculosis (21·8 per cent., Hector Mackenzie), and amongst women.

The long, flat, phthinoid chest and, in women, the broad renal fossa with wide lower end are predisposing causes. Injury in a few cases may be a directly exciting cause, and probably acts by tearing the ligaments which limit excessive movement in those already predisposed to the condition.

Congenital cases occur, especially in men. Their origin is revealed by other concomitant congenital defects, such as abnormal origins of vessels, or strictures and kinks of the ureter.

True floating kidney is occasionally met with on the left side, but its comparative rarity has caused much speculation. Probably the different relation of the splenic flexure, which from an early period becomes firmly fixed to the parietes above the left kidney, from that of the hepatic flexure, which lies in front of the right kidney, and does not anchor at all, is the most important factor. Keith* has also pointed out that when a viscus has to give way on the left side, the stomach and transverse colon are the first to prolapse, and so prevent the stress from falling on the spleen, splenic flexure, and left kidney.

Still, it happens sometimes that, without any evidence of a general tendency to visceral prolapse, both kidneys may be freely floating, and in such cases the symptoms will not be relieved unless both are fixed.

A most instructive case was that of a woman with a horseshoe kidney which was floating and causing much gastric and nervous disturbance. The right half of the common kidney was fixed from behind with a series of kangaroo-tendon sutures, and as the two kidneys were fused together at their lower end it was thought that this fixation would prove enough. Although much relief followed, the left half of the organ continued to cause pain by coming forwards, and a second operation on this side led to a complete cure (J. H.).

The exact level at which the floating kidney should be secured to the posterior abdominal wall is probably not a matter of importance. It cannot be urged too strongly that the normal kidney has a certain amount of vertical mobility, and that its position with regard to the lower ribs varies in different individuals. The operator aims at preventing the kidney from tilting or floating forwards in the future rather than at restoring it to its exact original level.

* Clifford Allbutt, "System of Medicine," vol. iii., 1907. "Splanchnoptosis."

It is unwise to attempt to fix the kidney to the twelfth rib, whose movement is opposed to the natural movement of the kidney. During the strain of coughing or vomiting a kidney so fixed might be torn from its moorings. Further, in the passage of the sutures there is some risk involved to the pleura. An operation for floating kidney to be effective should form part of a course of treatment which aims at attacking the causes; it must be designed to remove the lax perinephric tissue and replace it by *firm yet elastic adhesions* running from the surface of the kidney to the back wall of the belly. Such adhesions *will allow of respiratory excursions*, yet will tend for a time at least to *limit this excursion* within safe bounds, giving time for the rest of the treatment to bring into play the natural supports of the kidney. Such pathological adhesions, being far stronger and less extensible than the areolar tissue of the fatty capsule, may be able to take a larger share in resisting the forces which may tend to displace the kidney.

The object of the operation, then, is not to form fixed supports for the kidney, but to form bands which shall limit excessive movements. The kidney should be anchored rather than fixed.

Cases in which the normal mobility of the kidney in the vertical plane is increased are not suitable for operation. A floating kidney is one which is liable to come forwards in the abdomen, the lower end of the organ being felt near the anterior wall of the latter. *It is only the true floating condition which causes symptoms, and it is only such cases that should be subjected to operation.*

The various methods that have been devised and recommended may be grouped in three classes:

(1) Through a lumbar incision the kidney is completely exposed and cleared of fat. It is then fixed to the posterior muscles by a series of kangaroo-tendon sutures, which take a firm hold of the undivided capsule and dip slightly into the cortex. This method has given excellent results in a long series of cases operated on by one of us (J. H.).

(2) Through a similar incision the capsule of the kidney is divided and reflected, either as one or two flaps or in bands. The reflected capsule is fixed with sutures to the muscles of the posterior abdominal wall.

(3) Stanmore Bishop, Harris of Chicago, Alexis Thomson, and others advocate exposure of the kidney from in front through the linea semilunaris or thereabouts. A flap of renal capsule from the front is turned down and sutured to the front of the quadratus lumborum, and over the lower end of the kidney the peritoneum is tightened up by deep sutures. Mr. Stanmore Bishop, in an excellent monograph, has given a full description of the method, but we do not think it will come into extended use. Apart from the fact that the ascending colon and its vessels are much in the way during the operation, the method only fixes the lower pole of the kidney, and it appears to us to have less to recommend it than the operations from behind.

These three methods will now be described. No special instruments except large retractors are required for either operation.

(1) POSTERIOR NEPHRORRAPHY WITHOUT REFLEXION OF CAPSULE

The patient is anæsthetised in the ordinary position, and is then turned well over on to her left side, a large sand-bag or firm pillow being placed beneath the loin so as to render the right renal region convex. Both the patient's lower limbs and trunk are flexed; the right arm is prevented from pressing on the chest by being supported on a metal rest attached to the operating table, or it may be held by an assistant.

It is important to render the operation region as accessible as possible by the means described before starting the operation. The surgeon feels for the outer border of the erector spinæ muscle (about three inches from the line of spinous processes, and marked by a slight vertical depression), and also for the last rib. From the angle between these two lines he makes an incision downwards and slightly forwards towards the crest

of the ilium. This incision is carried boldly through the external and internal oblique muscles to the aponeurosis of the transversalis muscle, which is recognised by its firm white appearance and the transverse direction of its fibres. This aponeurosis is cut through, and the special layer of transversalis fascia, which does not adhere at all closely to the muscle, is then also divided. Care should be taken not to open the peritoneum, as the intestine is sure to get in the way; still more important is it not to touch the colon, which is empty and possibly distended with gas. The transversalis fascia should be incised towards the inner side of the wound—*i.e.* over the kidney rather than over the colon; and the aperture, if required, can easily be enlarged with the fingers. Large curved retractors being in place, the kidney is sought for and, if necessary, gently pushed up towards the wound by an assistant pressing with his hand against the anterior abdominal wall. This procedure is, however, rarely required. The whole of the posterior surface of the kidney must be cleared, so that it is completely exposed ***in its true capsule.*** Any redundant fat is cut away with scissors. The condition of the upper end of the ureter and the kidney itself is examined by palpation. Four large fully curved needles, threaded with kangaroo tendon, are then used to fix the kidney in place. Each needle, held in an ordinary holder, is passed through the deep muscle edge (chiefly quadratus lumborum with transversalis and internal oblique), beginning at the upper end of the wound near the last rib. It is then made to traverse the capsule of the kidney, dipping a few millimetres into the cortex, and takes a broad hold of the kidney, emerging one to two inches from the point of entrance, then again through the muscle edge on the inner side of the wound.

All the four sutures are passed in the same way, each lying transversely to the vertical axis of the kidney, and each dipping slightly into the cortex. The upper one will, of course, be near the top of the organ. The ends of the sutures are held separately in forceps until all have been introduced; care is taken to avoid the last dorsal or other nerves before tightening them up.

Gentle traction being made on all the sutures, it will be seen that the kidney is perfectly and firmly secured against the posterior abdominal wall. The sutures are now tied moderately tight, and a few additional tendon stitches introduced, if necessary, to close the muscular wound completely. The skin is sutured with silkworm gut; a small drainage tube (left in for forty-eight hours) is advisable.

After-treatment, and Notes on the Operation.—The after-treatment is of the simplest. The rigid enforcement of the supine position for three weeks, which used to be and is still by some insisted on, is not at all necessary. But the operator should expect there will be a certain amount of pain following the operation for a day or two. By whatever method nephrorraphy is done, this pain is usually met with; it is certainly not due to nipping of sensory nerves, and it is of the kind which might well be attributed to altering the tension or position of the renal sympathetic plexus. Hence a hypodermic of morphia or a similar sedative by the mouth will be useful the first evening after the operation.

The wound heals almost invariably quickly and well, and the urine, though it may contain a drop or two of blood the first day, is normal after that. A fortnight in bed, during which constipation is of course guarded against, will suffice, and afterwards the patient should be encouraged to take all reasonable exercise. If of very spare frame, she should be given fattening food, though not with any special idea of promoting the fixation of the kidney thereby.

The tendon sutures will remain for years, and may be trusted to keep the kidney in place, short of some fall or very violent exertion.

Many operators employ silk instead of kangaroo tendon, but in our opinion the latter is far superior to silk, which is prone to set up sinuses, or even, in some cases, a urinary fistula.

The tendon, before being used, should have been immersed for some minutes in cold sterile water, to remove all trace of antiseptic which might irritate.

It has been urged against this method of nephrorraphy that the renal cortex, and possibly the pelvis or one of the calyces, are damaged. It may again be insisted upon that the whole posterior surface of the kidney must be well cleared and exposed before any of the sutures are introduced. To pass them so deeply into the kidney or so far to its inner side as to traverse the renal pelvis or one of the calyces would imply great carelessness or clumsiness on the operator's part.

Several other methods of fixing the kidney by sutures without reflecting its capsule have been described. M. Vulliet devised the ingenious plan of using a strip of the erector spinæ muscle of the patient, which he detached at one end only, and threaded on a large needle, and then passed it beneath the capsule in a vertical direction. The other end of this tendon-sling was fixed to the posterior abdominal wall in the best way that could be managed. The method is awkward to carry out, and is much inferior to using four separate tendon bands, which are quite as permanent as the human one.

(2) POSTERIOR NEPHRORRAPHY BY MEANS OF SUTURING THE REFLECTED CAPSULE

The kidney having been exposed from behind, as already described (page 489), the perirenal fat is torn away with sponge-holding forceps, and the kidney and upper portion of the ureter stripped cleanly and completely from their bed. A thorough examination must now be made of the ureter, pelvis, and kidney, to exclude kinks or strictures of the ureter, aberrant vessels, dilated pelvis, stone, tuberculosis, and other diseases of the kidney, which may require further operative procedures. The kidney is reduced on to the surface for decapsulation. An I-shaped incision is made with a sharp knife through the true fibrous capsule, care being taken to spare the underlying cortex. The vertical limb of the incision runs along the convex border of the kidney from one end to the other. The capsule is stripped off the cortex so as to lay bare at least half of the anterior and the whole of the posterior surface of the kidney. It can usually

be peeled off quite readily with the aid here and there of a blunt dissector or the point of the knife, except when there has been long-standing inflammation. Gentle pressure with a hot sponge will quickly put a stop to any excessive oozing from the cortex. The capsule is rolled back on each side, and four silk or kangaroo-tendon stitches are applied to it on curved needles in the following manner, two in front and two behind. The upper posterior stitch is made to penetrate the rolled capsule from without inwards at the level of the middle of the kidney. It is then passed vertically upwards for about an inch, and is brought out again from within outwards. The two free ends of the stitch are left hanging from the wound and clipped with pressure forceps. The lower posterior stitch is next applied in similar fashion through the capsule near the lower end of the kidney. The two anterior stitches are applied at the same levels and in the same way.

It is better not to apply stitches at higher levels than these, as the upper end of the kidney should usually overlap the twelfth rib when replaced in the wound, whereas the stitches are to be placed below that level. (Frederick Eve, *Brit. Med. Journ.*, Jan. 4th, 1908.)

The kidney is replaced in its bed, which has been entirely stripped of fat, and pushed upwards until the vessels appear to lie transversely. In this way an idea is obtained of the natural level of the organ.

At the appropriate level thus determined, the ends of the posterior sutures are passed through the quadratus lumborum and tied firmly, but not too tightly, so as to allow a little play. They should restrain rather than fix the kidney. The two anterior sutures are passed through the muscles of the outer edge of the incision at suitable levels and tied in similar fashion. The anterior sutures are not essential, and can be omitted, in which case the anterior portion of the stripped capsule should be cut away altogether.

All bleeding is arrested and the wound in the parietes closed with drainage.

The wound is dressed, pads of wool are placed over the front of the loin, and a firm broad flannel bandage applied to the abdomen from below upwards, one or more turns being taken round the thigh. The patient is placed in bed flat on her back, with the foot of the bed raised on six-inch blocks. This position is maintained for fourteen days. The bed is then lowered, and the patient lies recumbent for at least another week. Care should be taken to prevent or diminish movements of coughing and vomiting, and the bandages must be kept firmly applied. A belt is fitted during this period, without which the patient should on no account be allowed out of bed.

The after-treatment must be carried out for many months if the operation is to be a complete success. This consists in graduated exercises to strengthen the abdominal muscles and diaphragm, an efficient support being worn in the meantime, and treatment aimed at removing removable causes, whether these be deficient nutrition, undue compression, or increase in size of the viscera themselves.

Note.—In cases treated by the first method (kangaroo-tendon suture through undivided capsule) we have not found the elaborate and lengthy after-treatment just advised to be ever called for. As soon as the wound is soundly healed the patient is allowed up and encouraged to take moderate exercise, wearing a light corset or belt.

(3) NEPHRORRAPHY FROM IN FRONT

This differs from the previous methods chiefly in that the peritoneal cavity is opened in order to approach the kidney. The following account is abbreviated from Stanmore Bishop's paper, to which very full account the reader may be referred for further particulars ("On Mobile Kidney," reprinted from the *British Gynæcological Journal*, 1907):—

"The patient lies on her back. An oblique incision is made from the tip of the tenth rib—*i.e.* outer edge of rectus muscle—to a point midway between sternum and spine on a level one inch below the border of the ribs. This incision is therefore

much more transverse than vertical, being the same as that often used for cholecystotomy. The liver is drawn upwards, the hepatic flexure of colon downwards, the kidney and renal veins then come into view. A transverse incision is made through the peritoneum across the lower fourth of the kidney and the peritoneal edges held aside, so that a flap of renal capsule can be turned downwards and sutured by two or three stitches to the fascia beneath. The wound already made in the peritoneum is sewn up with catgut. A series of catgut sutures are now made to skirt the lower border of the kidney, each long thread is on two needles, which are passed right through the abdominal wall, and buried after incising the skin in a semilunar line." Great care must be taken not to injure the ureter in passing the first suture, which Bishop directs should be introduced "immediately below the ureteric insertion."

It will be understood that the main idea of the operation is to support the lower end of the kidney by pinning back the peritoneum round it. The method seems to us to involve needless risk, and to offer little prospect of secure fixation.

6. URETERO-LITHOTOMY

A calculus may be impacted at the junction of the renal pelvis with its ureter, at the vesical orifice, or at any point between these two. Hence no fixed rules can be laid down for its extraction. In the majority of cases the stone should be cut down upon in the lumbar region through an incision made as for nephrotomy (*see* page 489). The Röntgen rays should always have been used beforehand, and the position of the calculus ascertained as far as possible. The lower end of the kidney and the pelvis having been identified, the calculus is sought by palpation. If it can be detected in or near the renal pelvis, the latter is incised, care being taken to avoid any aberrant renal vessels (it is quite common to find one or more branches of the renal vessels passing ***behind*** the upper end of the ureter). A gush of urine ensues, and the finger, being introduced, will perhaps succeed in extracting the stone

aided by pressure from below with the left hand. A small lithotomy scoop or forceps such as are used in cholecystotomy may be required, and the forceps should have a secure grip to prevent the stone from slipping out of their grasp.

If the calculus be fixed in the ureter too low down to allow of its being pushed upwards into the pelvis, the ureter itself must be incised. Before doing this it is always well, if possible, to push up the stone some little way, as the ureter in the immediate neighbourhood of the stone is inflamed, and in a poor condition to take sutures, to withstand traumatism, and to heal soundly, and also the tube above the stone is dilated, and therefore easier to deal with. The stitches should be placed in position ready for tying before the incision is made, the stone being thus used as a support to the walls of the duct and rendering the application of the sutures easier. A strip of gauze or a small sponge is first of all placed beneath the ureter to catch any urine that may escape. The sutures are applied with fine reversed Hagedorn needles held in Halsted's needle-holder in the following manner:—The first is applied on one side of and parallel to the line of the intended incision, *taking up the external and muscular coats only*. The ends are left hanging loose and are clipped together by pressure forceps. The second is applied on the opposite side of the intended incision in similar fashion, Another pair of stitches is inserted in the same way just above. An assistant employs gentle traction on these stitches while the surgeon makes a longitudinal incision rather less than half an inch long directly on to the stone, which is removed with the aid of a scoop.

FIG. 141.—METHOD OF SUTURING THE URETER BY MATTRESS STITCHES.

After a bougie has been passed up to the pelvis of the kidney and down into the bladder to prove that the ureter is free, the wound in the ureter is drawn together by tying the corresponding ends of the stitches to each other across the wound. If there is any leakage of urine one or two extra stitches may be required.

If the stitches be applied in this manner without encroaching upon the mucous membrane, there can be no harm in using fine silk. If this care is not taken catgut must be used.

Mr. Morris writes: "The dread of these (silk sutures) becoming the nuclei of calculi has been often expressed; but so far as I have found at present it has no more foundation in fact than the former similar scare about sutures passed into the renal parenchyma. . . Does calculus form on these sutures? We have no proof at present that it does."

The proof can be found in a case reported by Mr. Rigby (*Annals of Surg.*, November, 1907), in which a patient after suture of the ureter with silk manufactured three stones within six months each containing silk sutures. Silk stitches should therefore never be allowed to penetrate the mucous membrane of the ureter.

A drainage tube is passed down to the incision in the ureter and the remainder of the wound is closed.

If, however, it is previously known that a calculus is impacted within a few inches of the bladder, an incision should be made similar to that used for ligature of the common iliac artery. The patient is placed on his back with a sand-bag under the buttock on the side of the incision. This incision is made just above and parallel to the outer half of Poupart's ligament, curving upwards and slightly inwards when it reaches the level of the anterior superior spine. The abdominal muscles and transversalis fascia are divided in this incision until the subperitoneal fatty layer is reached; the peritoneum is then gradually pushed inwards until the ureter is seen as it crosses the bifurcation of the common iliac artery. Its identification will probably be rendered easy by its distension with urine; the distended part may measure two inches or more in diameter. Whilst his assistant presses aside the peritoneum, the operator opens the ureter longitudinally, as described above, and after the urine has escaped into a sponge held ready for it, he passes bent forceps down to grasp the stone. If the patient be a

woman, the manipulation will be much aided by the index finger of an assistant in the vagina pushing upwards and steadying the stone. If a man, a finger in the rectum can perform the same service. In this way a stone low down can often be pushed up an inch or more into a more accessible portion of the ureter. The stone is usually elongated, with its long axis in the line of the ureter. Should the patient be thin, the ureter will probably be reached with ease, and the extraction of the stone may present no difficulty. Far otherwise is it if the patient be stout, when the search for a small calculus at the depth of some eight inches of fat from the surface, whilst venous oozing is continuous, may tax the resources and patience of the operator to the utmost.

It is needless to say that in such unfavourable circumstances no attempt need be made to suture the wound in the renal pelvis or ureter; but in ordinary cases such suturing should be employed as a routine measure. In any case due provision should be made for drainage of the wound.

In order to expose the greater part of the ureter from the renal pelvis down to near the bladder, a very long incision (lumbo-ilio-inguinal) is advocated by Mr. Morris. This incision commences under the last rib, passes forwards and downwards across the ilio-costal space, curves round the iliac crest one inch to the inner side of the anterior superior spine, runs parallel with Poupart's ligament, and ends nearly at the external abdominal ring.

The peritoneum must on no account be opened, and the spermatic vessels in the male, the ovarian in the female, must be carefully avoided.

So long as the stone is not fixed, but can be pushed up the ureter from below, there are very few stones that cannot be removed by this route, even in the female; but if the stone be firmly fixed just above the wall of the bladder, approach to it will have to be made some other way.

In the female the vaginal route will probably be selected, but in the male the best route is perhaps the parasacral route,

first employed by Mr. Morris and carried out recently with success in four cases by Mr. Hugh Rigby. For details of these operations the reader is referred to Mr. Morris's book and to Mr. Rigby's paper. If the stone is intramural, it is best removed through the bladder.

7. URETEROTRESIS

This operation, or its alternative, nephrotresis, will be adopted more and more in the near future, as the radical treatment of total excision of the bladder for carcinoma becomes more widely adopted. At present it is impossible to say which operation gives better results. Some authorities state that stricture of the opening and ascending infection of the kidney are more often met with after ureterotresis than after nephrotresis. The operation is made possible by the improvements in the manufacture of instruments designed to collect the urine from the wounds in the loin. (For full description of such instruments the reader is referred to *Annals of Surgery*, September, 1907, pages 430–438, Francis Watson; and December, 1907, pages 952–956, T. Rovsing.) With these it is possible to keep the patient dry and free from unpleasant odour.

The operation advocated by Rovsing is performed as follows :—

Short oblique lumbar incisions are made in the loin on either side extending laterally four inches from the outer border of the erector spinæ. Each ureter is found, and is hooked out into the wound. It has previously been cut and ligatured during the pelvic operation on the bladder. The lower end is dissected out and drawn out of the lower end of the wound. The lumbar incisions are now sutured, with the exception of the extreme lower ends through which the ureters hang free.

Rubber catheters are inserted into the ureters until they pass a little beyond the surface of the abdominal wound. The ureters and catheters are left hanging free in a glass receptacle. Externally, the ureters are drawn through perforated rubber finger cots and thereby protected.

The ureters heal into the wound and the dependent portions

shrivel up to within an inch or less of the wound. The remainder become covered with epithelium and project as small beak-like urethræ above the skin level. The urinary receptacles are fitted round these papillæ when the wound has healed. If there is any tendency to stricture, bougies should be passed at intervals with careful aseptic precautions.

Decapsulation.—Of late years Reginald Harrison, Edebohls, and others have advocated capsulotomy or incision of the true capsule, and decapsulation or complete stripping of the true capsule, for certain cases of nephritis. The objects in view are to relieve intracapsular tension, and to increase the blood supply of the damaged organ by the formation of fresh blood-vessels between the kidney cortex and the transversalis aponeurosis. Many experiments on animals have been made by different observers to find out whether such blood-vessels do form after decapsulation, so far with most conflicting results. Not enough well-ascertained facts are as yet available to enable judgment to be passed on this operation. The chief indications appear to be (1) cases of acute nephritis with suppression of urine, (2) progressive cases of chronic nephritis that do not yield to medical treatment. The operation is the same as that described under Nephropexy, save that the capsule is completely cut away, and no stitches are inserted in it.

INJURIES OF THE URETER

Ruptured ureter from external violence is very rare, but the ureter is sometimes cut across or occluded in a ligature, especially during operations for the removal of the uterus and in dealing with strictures of the ureter. If the cut ends be united transversely by suture, a stricture forms and causes atrophy of the kidney. It would be possible, however, to dilate this stricture with bougies at regular intervals. The best method whenever feasible is vesico-ureteric grafting, but if the upper part of the ureter is cut some method of direct suture must be used.

Van Hook's Method.—Fenger (*Annals of Surg.*, vol. xx., 1894) describes this operation as follows (*see* Fig. 142) :—

1. Ligate the lower portion of the tube one-fourth of an inch from the free end, using catgut. Make with fine, sharp-pointed scissors a longitudinal incision, twice as long as the diameter of

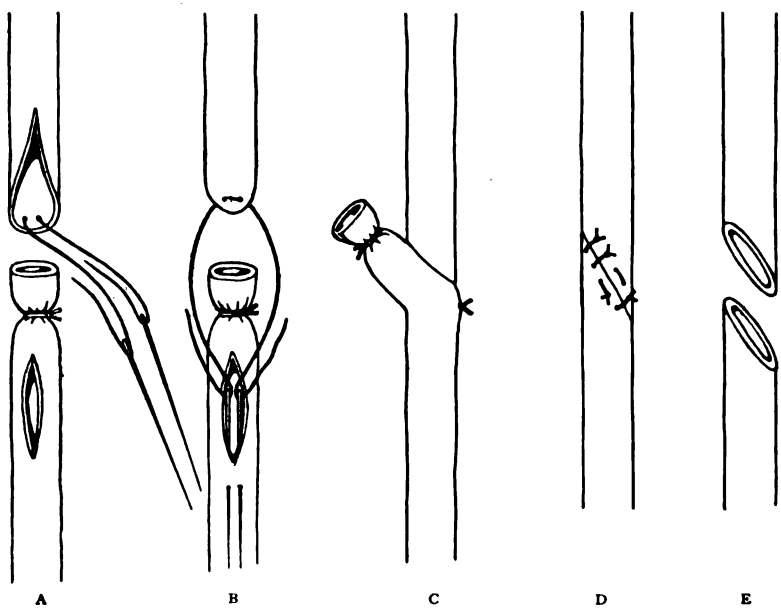


FIG. 142.—UNION OF THE DIVIDED ENDS OF THE URETER.
A, B, C, Van Hook's method; D, E, Oblique end-to-end method of Bovée. (*See text.*)

the ureter, in the wall of the lower end, one-fourth of an inch below the ligature.

2. Make an incision with scissors in the upper portion of the ureter, beginning at the open end of the duct and carrying it up one-fourth of an inch. This incision ensures the patency of the tube.

3. Pass two very small cambric sewing-needles, armed with one thread of fine catgut, through the wall of the upper end of the ureter, one-eighth of an inch from the extremity, from within outward, the needles being one-eighth of an inch apart

and equidistant from the end of the duct. It will be seen that the loop of catgut between the needles firmly grasps the upper end of the ureter.

4. These needles are now carried through the slit in the side of the ureter into and down the tube for one-half an inch, where they are pushed through the wall of the duct side by side.

5. It will now be seen that traction upon this catgut loop passing through the wall of the ureter will draw the upper fragment of the duct into position. This being done, the ends of the loop are tied securely together, and as the catgut will be absorbed in a few days, calculi do not form to obstruct the passage of urine. One or two fine catgut sutures of reinforcement may be inserted, picking up the outer coats of the tube.

Method of Bovée.—If there is not enough ureter left to permit of Van Hook's method being adopted, the ends can be united by the method of Bovée. Each end is cut across so as to furnish an oblique opening. These openings are then stitched together with fine catgut stitches. There is less tendency to stricture if the line of union be oblique rather than transverse.

Cysto-ureterotresis.—The patient lies on the back with a sand-bag under the buttock on the same side as the intended incision. The pelvic portion of the ureter and the side of the bladder are exposed by the extraperitoneal method, using Mott's incision for the ligature of the external iliac. This starts at the centre of Poupart's ligament one and a half inches above it, curves upwards and outwards, so as to pass one and a half inches to the inner side of the anterior superior spinous process of the ilium, till it reaches a point some two inches above the level of the spinous process. The peritoneum is exposed and stripped inwards, so as to display the ureter as it crosses the common iliac artery and the side of the bladder.

The ureter is cut across as low down as possible, a catgut ligature being applied to the lower end, and is brought into the

forepart of the wound. It is then split, and a catgut ligature applied to it exactly as in Van Hook's method just described. A pair of long, narrow-bladed bladder forceps is then passed into the bladder through the urethra in the female, through a median perineal urethral section wound in the male. The forceps are pressed against the bladder wall at a suitable spot, and incision is made directly on to them through the bladder wall, the length of the incision being equal to twice the diameter of the ureter. The forceps are made to grasp the catgut suture and pull the ureter through the incision until its extremity lies just inside the bladder. The outer coats of the ureter are united to those of the bladder by means of interrupted sutures of fine catgut.

The wound is stitched up, an indiarubber drainage tube being left in, which leads down to the site of the anastomosis. After sound healing has occurred the opening should be inspected at intervals to see that it remains patent. If stricture occurs, it can be dilated through the cystoscope.

PLASTIC OPERATIONS ON THE URETER AND PELVIS

Stricture of the ureter at its insertion into the renal pelvis, combined with secondary valvular obstruction and high insertion of the ureter, is by no means uncommon, and is a cause of hydronephrosis.

Having exposed the kidney and upper end of the ureter and established the diagnosis, cut the ureter across obliquely at the level of the lower pole of the kidney. Cut away the exuberant inner portion of the dilated pelvis containing the proximal end of the ureter, taking care to avoid the large vessels running across to the kidney.

Stitch up the wound in the pelvis in a vertical manner with the exception of the extreme lower end, using fine catgut stitches. With a pair of scissors inserted down the open end of the distal part of the cut ureter, make a vertical slit on its outer side half an inch in length. Unite the oval opening of the ureter thus made to the lower end of the wound in the renal pelvis by means

of fine catgut stitches. Add a few stitches here and there when leakage appears or support seems needed. Stitch up the wound in the parietes, leaving an indiarubber drainage tube leading down to the ureter.

Stricture of the ureter may occur in any part of its course. Most of these cases are congenital, a few are the result of injury such as that caused by calculi.

The diagnosis can often be established by means of the ureteric catheter, and treatment is possible by intermittent dilatation with bougies passed with the aid of the cystoscope.

If, however, the condition be found at an exploratory operation, the following is the best method to adopt for relief:—

The site of obstruction having been exposed, incise the ureter longitudinally half an inch upwards from the site of the stricture, thus exposing the upper opening of the stricture. Continue the longitudinal incision downwards through the stricture and the ureter below for another half-inch. Stitch up this longitudinal wound transversely as is done in pyloro-plasty, using fine catgut sutures on a curved needle. It is better to avoid piercing the mucous membrane with these sutures. Close the wound with deep drainage.

If the stricture show any tendency to return, dilate it with bougies passed with the aid of the cystoscope.

CHAPTER XX

OPERATIONS ON THE BLADDER

THE modern treatment of vesical calculus may be summed up thus: Nearly every stone can be crushed and evacuated at one sitting, and hence litholapaxy has not only become the routine operation, it has entirely superseded lateral lithotomy. A cutting operation is still sometimes resorted to either for very large calculi, for the rare cases of stone impacted in a pouch of the bladder, or for those complicating an enlarged prostate. For all these cases suprapubic cystotomy will be employed, and it may be added that with some surgeons unpractised in the use of the lithotrite the suprapubic operation may be the safest. Now and then a small calculus lodged in the prostatic urethra is extracted by means of the old operation of median lithotomy.

We shall now describe (1) litholapaxy, (2) suprapubic lithotomy, and (3) median perineal lithotomy, and shall then deal (4) with the treatment of stone in women, (5) with the removal of tumours of the bladder, (6) with the partial resection and (7) with the total resection of the bladder.

The long history of the evolution of modern methods of treating stone in the bladder may be omitted. Suffice it to say that the late Sir Henry Thompson was the great pioneer of lithotrity, and that the lithotrite in present use was devised and employed by him with unrivalled success.

No description of the perfected instrument is called for. It is the outcome of innumerable experiments and of infinite ingenuity, and as an example of applied mechanics is without an equal in the surgeon's armamentarium.

In 1878 Professor Bigelow proposed the method of lithotrity

with which his name is associated, and to which he gave the title of litholapaxy. The ground had been prepared by the researches of Otis, who had demonstrated that the urethra could take with safety instruments of infinitely larger calibre than had ever been supposed. The way was thus made clear for the employment of large evacuating catheters, by means of which all *débris* could be removed. The use of anæsthetics, and the demonstration of the tolerance of bladder and urethra of the long-continued contact of instruments, completed the bases for the operation.

I. LITHOLAPAXY

Preparation of the Patient.—In an ordinary case no special preparation is needed. It is well, however, that for some days before the operation the patient should rest quietly in bed, and should sleep well. His diet should be simple and non-stimulating, and the action of the bowels should be attended to. The urine should of course, be examined, and if found to be alkaline or to contain pus, an attempt should be made to render it acid and aseptic by the administration of urotropine, etc. It is, however, often impossible to cure the cystitis until its existing cause, the stone, be removed. It is assumed that the urethra is in a condition to admit a sufficiently large lithotrite and evacuating catheter. There is no need that the bladder be injected with fluid before the operation. The patient should not empty the viscus, and if three or four ounces of urine be retained at the time of the operation, so much the better.

The patient should lie flat upon the back upon the operating table, and close to the right-hand edge. The pelvis should be raised above the level of the shoulders by means of a firm pillow. This has the effect of causing the stone to gravitate towards the fundus of the bladder.

The surgeon stands to the patient's right. The assistant takes up his position upon the opposite side of the table, and attends to the filling and adjusting of the evacuating apparatus.

The thighs should be so separated that there is an interval of a foot or more between the knees. The patient is anæsthetised. In suitable cases the operation may even be performed without an anæsthetic. If any doubt exists as to the capacity of the urethra, a sound of suitable size may be passed. In some instances it may be necessary to incise the meatus.

Before using the lithotrite the surgeon should have made himself thoroughly familiar with the instrument, and should have practised crushing operations with it outside the body.

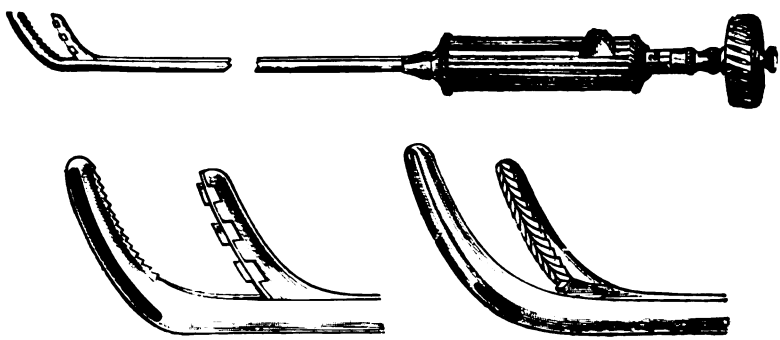


FIG. 143.—LITHOTRITE.

(The lower cuts show fenestrated and non-fenestrated blades.)

Bigelow's form of lithotrite and evacuator (Weiss) are strongly recommended. They should be fully fenestrated, though it is advisable to have one non-fenestrated for occasional use. The lithotrites must be of the best-tempered steel, and their crushing power tested before the operation. The smallest size (for children) is about No. 6 (English scale), the largest (for adults), No. 18.

The Operation.—No better account of the manipulations involved in lithotrity can be given than is provided in the description by Sir Henry Thompson. The account appended is derived from Holmes's "System of Surgery," third edition, vol. iii., page 294 :—

"The operator places himself on the right side of the patient, and stands with his back turned partly towards the head of the couch, his left side being to the patient's right. Having

well oiled the lithotrite, he holds it lightly with his right hand, in a horizontal position, the blades pointing downwards, and raises the penis with his left; and as he introduces the blades into the urethra, the left draws the penis gently over the angular end of the instrument, which descends in this manner down to the bulbous portion of the urethra, the shaft rising gradually towards the perpendicular. Having arrived there, it is not now to be depressed as in catheterism, since this movement raises the point of the blades against the roof of the urethra in front of the deep fascia above the narrow orifice of the membranous portion, while the large capacity of the bulbous urethra favours the malposition described, and, if force is used to overcome the difficulty, laceration will probably take place. . . . In order to pass the blades easily and safely through the narrow membranous portion, it is necessary to maintain the lithotrite a few seconds at or near the perpendicular, permitting it to progress slowly in that position. This proceeding is accomplished by permitting a part of the weight of the instrument to act as the propelling power, while the penis is drawn upwards a little in the same—that is, the vertical—direction. In this position the blades slide through the bulbous portion, enter and traverse the membranous portion, and arrive at the prostate. Then, and not before, the operator gradually depresses the instrument towards the patient's thighs; the blades rise up through the prostatic portion into the bladder—a movement which is rendered more easy if a very slight lateral rotary motion is given to the instrument at this part of its progress. In ordinary —that is, normal—conditions the shaft of the lithotrite at the entry into the bladder forms an oblique line, and an angle of about twenty to thirty degrees with the horizon; and this it continues, as it slides easily and freely down upon the trigone to the posterior wall of the viscus. It will be obvious that the urethra now entirely loses its curve, being occupied throughout by the straight shaft of the lithotrite. The jaws being now closed, and lying at the bottom of the cavity, or nearly so, the finding and seizing of the stone have to be achieved. . . .

"First, nothing is more important at the onset to remember than this—namely, that quiet and slow movements of the jaws of the lithotrite in searching the bladder are desirable, because rapid movements produce currents in the urine, which keep the stone more or less in motion, so that it is less easily seized than when the surrounding fluid is in a state of rest. . .

"Let it be understood that the blades of the lithotrite have entered the cavity of the bladder, and that the instrument slides easily and smoothly down the trigone, which in the living and healthy organ is an inclined plane, although quite otherwise in the atonied and in the dead bladder. In many cases the instrument in thus passing grazes the stone, and the slightest lateral movement of the blades, right or left, will determine on which side it lies. Whether the stone is felt or not, when the blades have passed gently down in the middle line until a very slight check to their movement is perceived, the lithotrite should rest there for three or four seconds, and then the male blade should be slowly withdrawn, without moving any other part of the instrument, towards the neck of the bladder, until a very slight check is perceived in that direction, followed by another three or four seconds' rest, for currents to subside. Now the operator should quietly press back the male blade, without changing the position of the lithotrite, and almost certainly the stone will be seized. In other words: open; pause; close—that is all. It is necessary always to remember, when withdrawing the male blade, that it is never to be drawn out roughly, since in this action the sensitive neck of the bladder may easily be irritated.

"But if no stone is thus found, the operator again withdraws the male blade as before, but inclining to the right side about 45°, and closes without disturbing the central position of the instrument; if nothing is felt, he turns to the left in like manner, and closes. It is often right to open the blades before turning, for this reason: if the turn is first made and the blades are subsequently opened, the male blade as it is withdrawn will often move the stone away; whereas if the blades are inclined

while open, the stone, if there, is almost certainly seized. It is not very common for the stone to elude the search thus far; but if it does, depress the handle of the lithotrite an inch or so, an act which raises the blades slightly from the floor of the bladder, and turn them another 45° to the left—bringing, in fact, the blades horizontal to the left; close; if unsuccessful, turn them gently to the horizontal on the right, and close. In all these movements, if properly executed, there has been barely contact of the lithotrite with the vesical walls: at all events no pressure, nothing to occasion injury to the bladder. But if there is an enlarged prostate, causing an eminence at the neck of the bladder, or the stone is very small, or we are exploring for some fragment suspected to be present, the blades are to be reversed so as to point downwards to the floor, and the object sought may then often be secured with ease. If seeking for a small stone or for fragments, we may employ a lithotrite with short blades, which can therefore be reversed with greater ease than one with long blades.

"In order to do this properly, the handle of the lithotrite is depressed another inch or more between the patient's thighs, so that the shaft of the instrument, instead of being directed a little upwards, is level with, or points below, the horizon; the blades, being still closed, are cautiously brought round to the reversed position, and the floor first lightly swept, in the manner of a sound in searching for stone. Then they may be carefully opened and closed two or three times, in slightly varied directions, but without injuring the floor of the bladder; after which an exhaustive examination of its cavity ought to have been accomplished. It sometimes happens, when the prostate is considerably enlarged, and a stone or fragments have to be sought behind it, that the lithotrite can be reversed without depressing the handle.

"As a rule, all these movements are to be executed at or beyond the centre of the vesical cavity, the proper area for operating, without hurry, rapid movement, or any other which partakes of the nature of a jerk or concussion. The most

common cause of failure to seize a large stone arises from its close proximity to the neck of the bladder (whatever position is given to the patient), and from the male blade being drawn up against it at each opening of the lithotrite. In these circumstances, the operator feels the contact of the stone, without suspecting its precise locality, each time he withdraws the blade, and is apt to feel embarrassed on failing to seize it when he closes immediately after. In these cases it is essential to draw the male blade gently, but closely, to the neck of the bladder, and to slide the blade between the neck and the stone which lies in contact with it.

"The rules already laid down for finding and seizing apply more or less to lithotrites of moderate size, but this general rule may be borne in mind: viz. the more powerful the lithotrite—that is, the larger and longer are its blades—the less readily are we to adopt the reversed positions of the blades, and the more fluid is it desirable to have in the bladder. As large and fenestrated blades are used chiefly for the initial act of breaking up a large stone into fragments, it is obvious also that there is less occasion for the horizontal and reversed movements, since a large stone may almost certainly be seized by the right or left incline.

"Now, supposing that a hard stone of an inch and a half in diameter has fallen into the grasp of a powerful lithotrite. A slight to-and-fro movement is made to see that no portion of the bladder wall has been included in the jaws of the lithotrite; the screw is to be gradually turned at first, to make the blades bite, since a sharp turn at this moment may drive the stone out either right or left. As the power is increased, the resistance is felt to relax, sometimes by degrees, sometimes suddenly with a crack, and the stone is broken—usually into four or five large pieces, besides some small *débris*. This done, the male blade is again drawn out, taking care not to shift the situation or alter the axis of the lithotrite, and, almost certainly, one of the large fragments will be picked up. It is then only necessary to screw home, release the screw, and open as

before. This process may be repeated several times at the same spot, for the area within which the larger fragments fall is very limited, and is unchanged if all remains quiet. . . .

"Having now broken up the stone, and crushed well the largest fragments, and thus occupied perhaps from ten to fifteen minutes, it should be time to employ the aspirator, and remove a good quantity of *débris*. Accordingly, the screw of the lithotrite is driven well home, to close the blades, between which

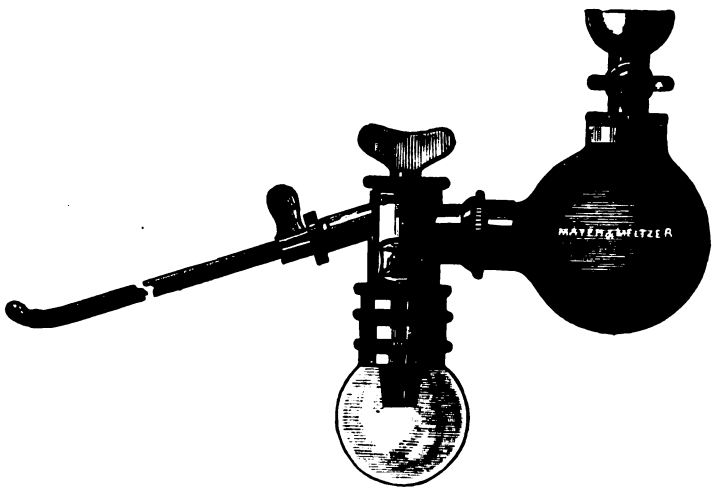


FIG. 144.—EVACUATOR FITTED TO CATHETER.

The glass globe and rubber aspirator are both filled with warm boric solution. The two taps are turned ready for use.

some calculous matter probably is engaged, and the lithotrite is withdrawn. An evacuating catheter of the size known to be necessary—No. 15 or 16 amply suffices for small stones; No. 17 or 18 may be employed for larger ones, if the urethra fairly admits it—is then introduced, and all the urine withdrawn. An aspirator previously filled (with a warm boric solution) is then attached, the connection-tap opened, and a small portion of its contents pressed by the right hand into the bladder, the left hand supporting and directing the evacuating catheter. On relaxing the pressure, an immediate current outward follows,

carrying with it very probably a fair quantity of *débris*. Wait some three or four seconds after expansion has finished, and the current apparently ceased, as at that precise time it is quite common for one or two of the large fragments to drop into the receiver, which would have been driven back perhaps by too rapidly resuming the pressure. This process is repeated several times, according to the amount of *débris* observed to enter the trap.

"If the patient is breathing heavily under the influence of ether, it is desirable to inject during the act of his expiration, and let the fluid flow outwards into the aspirator during his inspiration, which act assists the evacuation of the bladder.

"After a large crushing, the end of the evacuating catheter should not rest on the floor of the bladder, as it is then likely to be choked with *débris*. But after most of the fragments have been removed, it is advantageous to lower the end of the catheter, in order to catch the last fragments.

"If the outflow of the current is felt to be suddenly checked, and the aspirator ceases to distend, the operator may be almost certain that a fragment of a rounded or cubical form, or a small calculus, nearly fitting the interior of the catheter, blocks the passage and prevents further egress. The piece must be expelled by making smart pressure on the indiarubber bottle, after which the action of the aspirator will probably be resumed.

"If after crushing all the stone, so far as the operator is able to judge, and removing the *débris* largely, nothing is heard or felt in contact with the end of the evacuating catheters, notwithstanding that three or four successive pressures have been made, there is ground for believing that all the fragments may now have been removed. Perhaps there can be no better proof that the bladder has been emptied than is afforded by the fact that a succession of outward and inward currents through the aspirator shows no sign, either to the eye or to the ear, of the presence of another fragment.

"It may be added here that evacuating catheters of different patterns should be within reach. The curve, the situation of

the opening, may vary advantageously in different cases; the latter may be either terminal or lateral.

"If all has not been removed, the sound of a large piece perhaps making itself heard and felt at each outward current against the end of the catheter indicates that this must be withdrawn, and a lithotrite introduced. If the fragments are not of considerable size, a lighter and handier lithotrite may succeed with advantage to the heavy fenestrated one originally used, and the crushing continued. Of course, if more stone remains, the process is repeated once or more."

To make sure that all large fragments have been removed, a cystoscope may be inserted at the end of the operation, and the interior of the bladder inspected.

The following practical observations by Dr. Keyes may find a place here:—As the tube is moved from side to side, and particularly when the curved tube is inverted, the bladder wall often flaps with a sharp click against the eye of the tube, and then flutters spasmodically with dull thuds against the open end of the instrument. When the bladder is empty, the sharp click may be so hard in quality as to resemble the sound given by a fragment of some size.

Should air enter the bladder, it churns up the water, distends the bladder, interferes with the efficient washing-out of the viscus and with the recognition of small fragments. To dislodge the air, the bladder should be fully distended, and then the handle of the tube be fully depressed between the thighs, so that the open end may be raised to the top of the bladder. The evacuator is now worked slowly, the air escapes into the bottle, and, remaining at the top, can be allowed to escape.

Time occupied by the Operation.—From twenty to forty or seventy minutes will suffice for all ordinary cases. In one instance Bigelow operated continuously for upwards of three hours. The stone weighed 744 grains. The patient did well. Freyer observes:—"The amount of manual labour required for dealing with large calculi is excessive. My hands were

often blistered, and arms frequently ached for days after performing litholapaxy in one of these cases." During a protracted crushing it is important to guard the patient against chill.

Complications.—As a rule, the bleeding is trifling or absent. It may, however, be severe, and depend upon damage to the urethra, bladder, or prostate, or be due to the presence of a vesical growth. It is therefore a serious sign.

Complete clogging of the instrument with *débris* has occurred. This is only possible with the non-fenestrated lithotrite.

If the blades cannot be cleared, nor the instrument removed, it must be cut down upon from the perineum, and when cleared, must be withdrawn. The operation is then completed as a perineal lithotomy.

After-treatment.—The patient must lie in bed. An india-rubber hot-water bottle or a warm fomentation may be applied to the hypogastrium. Some opium may be required.

There may be some urethral fever, or retention of urine from atony of the bladder. Sir Henry Thompson points out that a little subacute cystitis not unfrequently appears on the fourth or fifth day. The administration of urotropine or cystamine in five-grain doses and the injection into the bladder of a few ounces of solution of nitrate of silver (half to one grain to the ounce) are useful for this complication. The patient should be kept on a light or milk diet, and remain in bed until any cystitis has subsided. If the stone is small and there have been renal symptoms, the opportunity should be taken to exclude the existence of other calculi in either kidney by skiagraphy. A warm hip-bath daily adds greatly to the patient's comfort. The urine contains no trace of blood as a rule after the second to the fourth day; and in the majority of cases the patient may be allowed to get up on the seventh day. An occasional and troublesome complication, met with especially in adults, is orchitis or epididymitis.

We have to consider (1) the immediate mortality of the operation, and (2) the chance of recurrence or re-formation of

a stone in the bladder. In comparing litholapaxy with lithotomy it may be said that, apart from the question of relative mortality, each has special risks, slight though they may be. After lithotomy —whether median or suprapubic—there is always a chance of the persistence of a urinary fistula, but it is improbable that any fragment of the stone should be left behind. After litholapaxy the chief risks are, leaving a fragment of stone in the bladder which may serve as a nucleus, and the supervention of cystitis or epididymitis. The direct mortality of litholapaxy in competent hands is very small. Taking the records of the late Sir Henry Thompson, Surgeon-Major Keegan, and Mr. Freyer, we find it works out at from 2 to 5 per cent., nearer the former than the latter figure. In fact, if the cases are selected with care it is quite likely that a surgeon may have a run of 100 cases without a death.

In America and England litholapaxy has so largely displaced lithotomy that it is difficult to obtain statistics as to the latter operation. But in several European countries litholapaxy appears to be hardly ever practised, and from them we get valuable evidence as to the mortality of the cutting operations. For example, two Russian surgeons, Dsirne and Gontscharow, report 400 cases of lithotomy. Of these, 234 were examples of median lithotomy with 11 deaths—*i.e.* about 5 per cent. There were 168 cases of suprapubic operation with only three deaths —*i.e.* 2 per cent.

The balance of evidence, so far as the mortality is concerned, is therefore rather in favour of litholapaxy ; but it is surprising how small is the difference in the figures. As regards the after-treatment and length of time the patient has to be kept in bed, it is quite another matter. After a successful litholapaxy the patient, if he escapes complications, will be fit to go to work in a few days. After a cutting operation, even if the bladder wound has been sewn up, three weeks at least, and possibly a good deal longer, must elapse before he is fit for active work again.

As regards the chance of leaving behind a fragment of stone

after litholapaxy, the danger of it is greatest in the case of very hard oxalate calculi, and of bladders which are somewhat rugose or sacculated. The peculiar click of a fragment against the eye of the evacuator should prevent the mistake, and if in doubt the surgeon will do well to introduce the cystoscope.

Mr. Cadge expressed his belief that the relapses after the old operation of lithotrity in several sittings reached to nearly 20 per cent. if the cases of phosphatic deposits and concretions common after this operation are included among the examples of recurrence of the stone. Litholapaxy is attended with no such proportion of unsatisfactory results; and, indeed, if the evacuator be carefully and thoroughly employed, the relapses after litholapaxy will probably include no cases of recurrence due to the actual retention and subsequent increase of a fragment.

OPERATIONS FOR VESICAL CALCULUS IN MALE CHILDREN

In these young male subjects the choice will lie between lithotrity at one sitting and suprapubic cystotomy. As a general rule, the former should be preferred.

Lithotrity and litholapaxy were formerly regarded as unsuited for the treatment of stone in male children, upon the following grounds:—(1) The smallness of the bladder; (2) the delicate character of the mucous membrane of the bladder and urethra, rendering it liable to laceration; (3) the small calibre of the urethra; and (4) the great success of lithotomy operations on children.

Dr. Keegan (*Indian Medical Gazette*, June and September, 1885) was the first systematically to demonstrate the fallacy of these objections, and in his hands it very soon became evident that litholapaxy offered an excellent means of treating stone in children.

(1) The bladder of a child, even if only two or three years of age, is large enough to allow of the manipulation of suitable lithotrites and evacuators. In Dr. Keegan's lists of cases will

be found several successful instances of litholapaxy in children of three, two and a half, and two years of age. One child's age is given as one year and three-quarters. The stone weighed eighteen grains, and the child left the hospital in four days.

(2) The mucous membrane is certainly delicate, but it is exposed to no especial risk of laceration if due care be employed. Dr. Keegan very properly insists that no one should attempt to perform litholapaxy in boys until he has first gained some experience of the operation in male adults.

(3) The urethra in male children is of much greater calibre than was supposed. The meatus is often very small, and has to be incised. Dr. Keegan states that the urethra of a boy from three to six will admit a No. 7 or No. 8 lithotrite (English), and that of a boy from eight to ten will admit a No. 10, No. 11, or possibly even a No. 14.

In the actual performance of the operation the following points need special note :—

(*a*) Care should be taken not to over-distend the bladder, as in children it is more liable to rupture than in adults. Cases have occurred in which, by too forcible distension with the evacuator, the bladder wall has given way with fatal result.

(*b*) The lithotrite must be completely fenestrated. For litholapaxy in boys Dr. Keegan advises a set of fenestrated lithotrites, running from No. 6 to No. 10. He states that with a No. 8 lithotrite and a No. 8 evacuating catheter it is quite possible to dispose of a mulberry calculus, weighing between 200 and 300 grains, in an hour's time.

(*c*) The evacuating catheter should be provided with a stylet, so that any fragment lodged in the eye may be displaced.

(*d*) The stone must be very thoroughly crushed, since the small size of the catheter will only allow comparatively fine fragments to pass. It is well that the first crushing should be as complete as possible, in order to avoid the unduly frequent passage of instruments.

The results of the operation in children are alluded to on page 569.

2. Suprapubic Lithotomy

The **suprapubic operation** may be indicated under the following conditions :—

(1) A large hard stone in the bladder—when, for instance, the long diameter exceeds one and a half inches. A soft calculus, largely composed of phosphates, may be safely crushed when much exceeding the above measurement (the exact size of any vesical calculus can always be ascertained beforehand by skiagraphy). It must be noted that the operator's experience with the lithotrite largely determines the size of the stone he may safely undertake to crush. The age of the patient is important. Lithotrity may be tried on an adult with a stone of a size for which a cutting operation would certainly be indicated in a young child.

(2) Encysted calculi, whether fixed in a pouch behind a large prostate or in a diverticulum from the posterior wall, can only be dealt with by suprapubic incision. In the former case the prostatic obstruction should, if possible, be removed at the same time as the stones. When a pouch exists in the posterior wall of the bladder bulging towards the rectum, it is almost certain that calculi will re-form in it, and the operation will require to be repeated.

(3) When a calculus has formed on a foreign body of such size and shape that its removal by the urethra is impossible.

Median lithotomy is indicated for calculi in the prostatic urethra or the prostate itself.

Anatomical Points.—When empty, the bladder is flattened and of triangular outline, and lies against the anterior wall of the pelvis.

Between this part of the pelvic wall and the adjacent surface of the bladder is a pyramidal-shaped space filled with a loose connective tissue. On the summit of the bladder is inserted the remnant of the urachus. The peritoneal investment of the viscus, so far as its anterior surface is concerned, never extends beyond the attachment of this structure.

To the bladder at its summit the peritoneum is firmly attached, but to the anterior abdominal parietes at the site of the reflexion of the membrane the attachment is remarkably lax. This loose connection of the peritoneum to the parietal tissues allows the serous membrane to accommodate itself to changes in the size and position of the bladder.

The conditions under which the fold of peritoneum at the reflexion can be displaced upwards, and a portion of the bladder be projected above the symphysis pubis, free of covering from the serous membrane, vary somewhat according to the age of the patient.

In the child the bladder is still rather an abdominal than a pelvic organ, its vertical axis is elongated, and its outline is more nearly oval. When distended, the organ tends certainly to project towards the pelvic floor on the one hand, while on the other it mounts readily over the symphysis pubis, and soon presents a fair non-peritoneal surface above that bone. By means of a frozen section Symington showed (*Edin. Med. Journ.*, April, 1885) that in the case of a male child, aged five, the injection of three ounces of water into the bladder caused the reflexion of the peritoneum to be carried 2·7 cm. (*i.e.* more than one inch) above the symphysis pubis.

It will be evident therefore that in children mere distension of the bladder—without the aid of any rectal tampon—will suffice to bring the viscus into a safe position for suprapubic lithotomy.

About 1880 the experimental work of Garson and of Petersen led to the general adoption of the *rectal bag* in suprapubic cystotomy. It has, however, been found that the bag may well be dispensed with, and that there are several dangers and disadvantages attending its use. Hence it has been generally discarded, and no description of it is therefore called for in these pages.

The empty bladder may be found in one of two conditions (as demonstrated by Hart in the adult female bladder). It may be small, oval, and firm, with its upper wall convex towards

the abdomen (the systolic empty bladder); or it may be larger, and soft, with its upper surface concave towards the abdomen, and fitting into the concavity of the lower wall or surface (the diastolic empty bladder).

When moderately distended, it is of rounded outline; when completely distended, it assumes a more oval outline and rises out of the pelvis. As the bladder becomes distended, its fundus extends more and more towards the perineum; its summit is brought more and more in contact with the anterior abdominal parietes.

When the bladder and the rectum are both quite empty, the apex of the bladder and the prevesical reflexion of peritoneum are a little below the upper margin of the symphysis pubis.

When the apex of the bladder is two inches above the pubes, and the organ is pressed against the abdominal wall, the peritoneal reflexion is probably not more than three-quarters of an inch above the same point of bone.

The mobility of the bladder and the laxity of the peritoneal fold vary greatly in different individuals, and are much influenced by the physical condition of the tissues. In two males, aged thirty-four and thirty-five respectively, an injection into the bladder of ten ounces raised the peritoneal fold in one case an inch and three-quarters, and in the other three-quarters of an inch. In fleshy and flabby subjects the bladder usually will rise easily out of the pelvis against the abdominal wall when only moderately distended.

Fig. 145 shows the effect of strong distension of the bladder in an adult. The bladder assumes a spherical form, the prostatic urethra becomes nearly horizontal, and the prevesical fold of peritoneum is raised 2 cm. above the symphysis pubis. It may be noted that in another case less forcible distension might raise the reflexion of the peritoneum more than in the experiment quoted. It is not safe to employ forcible injection of fluid, since this has led in some cases to rupture of the bladder. In the case of a child, about four to six ounces, in an adult from ten to twelve, may be taken as an average amount to

employ. The bladder should be slowly filled, and the surgeon should estimate the distension by his hand placed above the pubes.

Preparation of the Patient.—If the bladder be unduly irritable, it is recommended that it be washed out daily for some few days beforehand. The rectum must be well

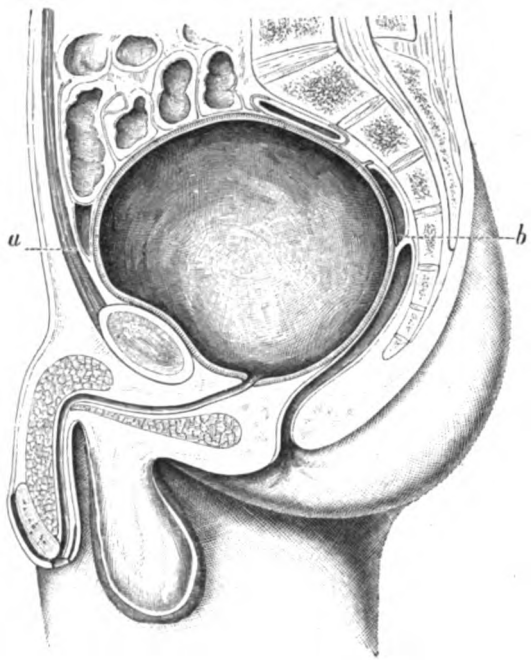


FIG. 145.—EFFECTS OF DISTENSION OF THE BLADDER UPON ITS POSITION.
a, Anterior, and *b*, Posterior, reflexion of peritoneum. (*Fehleisen.*)

emptied. In the adult the pubic region should be shaved. In any case, the skin is made as sterile as possible.

By means of the X-rays it is easy to have determined the exact size of the stone before operation. If more than one calculus be present the radiograph will have shown this to be the case.

The patient lies upon the back, close to the right edge of the table. The pelvis should be so raised that the intestines

fall away from the bladder. A few pads are wedged in against the perineum, to collect any blood or fluid which may run in that direction, and packing towels are placed under each loin.

The surgeon stands to the patient's right, and the chief assistant takes his place upon the opposite side of the table.

Instruments Required.—A scalpel; probe-pointed bistoury; scissors; sharp hook, blunt hooks; dissecting, artery, and pressure forceps; broad rectangular retractors; wound retractors; sound; lithotomy forceps and scoop; drainage tube for bladder; needles, sutures, ligatures, etc.; caissons; electric head-lamp.

THE OPERATION

Distension of the Bladder.—A soft catheter is passed, the urine is drawn off, and through the catheter the bladder is washed out with a warm boric solution (half an ounce to the pint). This is more conveniently done with an irrigator than with a syringe. The bladder is now filled with a weak warm solution of boric acid. In children from two to five years of age, three to six ounces will probably suffice; in adults, eight to ten or twelve ounces may be introduced. The injection should be carried out by means of an irrigator held three feet above the level of the table. The fluid thus enters the bladder with a more equable stream than when it is forced in by means of a syringe. The quantity of fluid required must be placed in the irrigator, and no more. If a piece of glass tubing be inserted in the irrigator tube close to the nozzle, the ease with which the fluid enters can be noted, as also the evidence of any backward pressure. The irrigator is detached, and a Wells forceps or clip applied to the catheter prevents the fluid from escaping.

Opening of the Bladder.—An incision about three inches in length is made precisely in the median line immediately above the symphysis. The incision should be extended about half an inch actually over that process of bone. There is no

linea alba below the umbilicus, and after dividing the skin and subcutaneous tissues, the surgeon may find muscular fibre lying across the line of the incision. If the interval between the muscles is not readily found, the knife should be carried directly through the muscle fibres themselves, the median line being strictly observed.

The wound must be a clean one, and any tearing of the parts with the fingers or forceps, or the handle of the scalpel, to seek for an intermuscular interval, is to be deprecated. When substantial and powerful muscles are met with, it may sometimes be advisable to divide the fibres transversely, to a slight extent, close to their attachment to the bone.

Any bleeding points are secured with pressure forceps, The transversalis fascia is reached, and is divided in the same precise manner in the median line.

The area of connective tissue overlying the summit of the bladder is now exposed. This must be cleanly and precisely divided with the scalpel, and the bladder reached by dissection.

The peritoneum may possibly be made out, and can be readily pushed upwards with the left fore-finger. The dissection necessary to expose the bladder should be commenced close to the symphysis, and be continued cautiously upwards. The peritoneum has been found adherent over the symphysis, and has been wounded. If such an accident should occur, the opening should be at once closed by fine catgut sutures. The safest course under such circumstances will be to defer completion of the operation for a few days until the peritoneum has healed. Particular caution must be exercised if a previous suprapubic cystotomy has been performed on the patient. In one such case (a second large calculus formed in a child) I (J. H.) found the peritoneal reflexion dragged down by the scar, but was able to avoid injury to it by working behind the pubis.

Wide rectangular metal retractors must now be used in order to extend the width of the wound to the utmost.

All bleeding into the lax connective tissue which is exposed must be arrested.

Several veins are met with ramifying over the apex of the bladder. They must be avoided. Should any be divided, the hæmorrhage may be free; but it will cease when the bladder is opened.

The prevesical fat may be considerable in quantity. It should never be torn through with the fingers or with the forceps and the handle of a scalpel. All such rough manipulations open the way for urinary infiltration. The exposure of the bladder should be, as already stated, by dissection.

All bleeding at this stage should be promptly checked, since the blood readily infiltrates the loose tissue in which the surgeon is working

The bladder is recognised by its pinkish colour, by its rounded outline, and by the exposed layer of muscular fibres. The peritoneum, if in view, must be pushed upwards with the left forefinger, while the surgeon transfixes the bladder with a sharp hook. This hook should be introduced transversely across the median line, and should be inserted near the upper part of the exposed viscus.

The scalpel is now thrust vertically into the bladder, exactly in the median line and just below the hook, and is made to incise the organ by cutting downwards towards the symphysis. It should be introduced with a sharp stab, lest the undivided mucous membrane be pushed inwards by its point.

The actual opening of the bladder is demonstrated by the escape of the contained fluid. The hold upon the tenaculum should not be relaxed. The cut margin of the bladder on either side of the opening should now be seized neatly and symmetrically with pressure forceps. These enable the operator to maintain a hold upon the organ during the remainder of the operation, and they render the position of the opening perfectly distinct.

Very little tissue need be taken up in the blades, and it has not been shown that the temporary compression with the instruments does any harm.

When the forceps are in place, but not before, the tenaculum

may be removed. Mr. Hurry Fenwick uses a blunt hook with a square end, which is inserted into the upper part of the wound and held up by an assistant. Some operators prefer to fix a stitch through the bladder wall on each side of the incision at this stage, to be used as retractors.

When the bladder collapses, the fold of peritoneum may present at the upper angle of the wound. The tenaculum keeps it out of the way, but it may be noted that the membrane has been inadvertently injured at this stage.

Unless means such as have been described are taken to prevent the sinking of the bladder, its anterior wall may descend into the pelvis, and much damage may be done to the soft parts in endeavouring to draw it up again. The finger should not be prematurely thrust into the opening, and should never be introduced until the margins of the orifice have been fixed. Ill-considered attempts in this direction may cause the bladder to be pushed before the finger, the opening to be closed, and the viscus to be separated from the surface of the pubes.

The hæmorrhage from the edges of the wound in the bladder may be a little free at first, but it soon ceases.

As soon as the bladder has been opened, an assistant may remove the soft catheter.

The surgeon holds the right-hand pair of retaining forceps, while the assistant holds the left; and with the opening thus fixed, the right forefinger is introduced into the bladder.

The opening may be enlarged with a blunt-pointed bistoury as required. There is no need to make the orifice so small that the finger has to be wormed in.

The stone is now extracted. For this purpose lithotomy forceps may be used, or the scoop may be found to be of greater service, or the two fore-fingers may be employed forceps-wise.

Should any *débris* remain, or should the urine be putrid, the bladder should be well washed out.

In a perfectly straightforward case this may be dispensed with. Before the operation is concluded, the interior of the

bladder should be thoroughly explored with the finger. The retaining forceps are removed from the bladder.

Two or three sutures of silkworm gut are introduced into the upper part of the parietal wound, each suture including the whole thickness of the divided tissues.

The question of suture of the bladder and total closure of the surface wound is considered in the next section.

Suturing of the Bladder.—This is an ideal method of concluding the operation whenever it can be carried out. The bladder wound should be closed by suture in children, and in healthy adults provided that the viscus itself is normal.

It is not wise to attempt it in aged subjects, in those who have cystitis, or in cases where the operation has been protracted and the margins of the bladder wound are much bruised, as in the extraction of a large calculus.

The application of the sutures is comparatively easy in children and in thin adults. It is difficult in the corpulent.

The opening into the bladder is fixed, and is held up by two blunt hooks, one inserted at each extremity of the wound. By means of these hooks the margins of the incision are kept steady and parallel with one another. Fine catgut should be employed. The sutures should be interrupted, and should be in two rows or layers. The deeper series should include the mucous membrane. The surface layer should include the other coats. All sutures should be introduced by means of a curved needle in a holder, and be very closely applied.

A small gauze drain is introduced into the lower part of the parietal wound, which is then closed.

A dry dressing is applied. The drain may be removed in forty-eight hours. Sometimes, however, leakage occurs after a few days, and drainage must be provided for.

The bladder is left undisturbed. No catheter is tied in, nor is any drain through the perineum necessary. If the patient cannot pass water, a soft catheter must be introduced as often as required.

After-treatment.—If the wound in the bladder has been

closed by sutures, the after-treatment of the case is conducted upon the lines observed after any ordinary abdominal section.

The question of the employment of the catheter has already been alluded to. The superficial sutures may be removed at the end of a week; and if all goes well, the patient may be sitting up in ten days.

If the wound in the bladder has been left open, it is dressed in the ordinary way, and about twelve hours after the operation

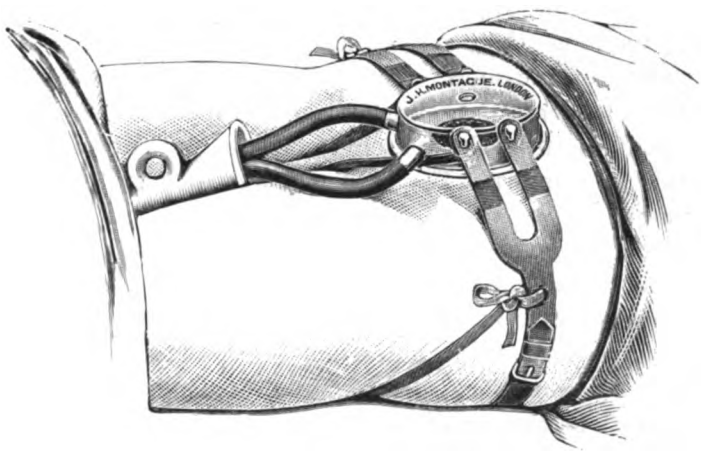


FIG. 146.—IRVING'S APPARATUS FOR USE AFTER SUPRAPUBIC CYSTOTOMY.

it should be covered by means of the dressing devised by Mr. Hamilton Irving, manufactured by Montague, of 69, New Bond Street, London, and described in the *Lancet* for Dec. 21st, 1907 (Fig. 146) :—

"It consists of a celluloid cap kept in place over the suprapubic wound by elastic pressure and possessing outlet tubes for the escape of urine. The celluloid portion is shaped like a straw hat having a small rim slightly curved with an upward concavity and a crown that can be removed like a lid. It is fastened in place by means of an elastic strap passing round the abdomen, to the ends of which elastic bands are fixed, and a tendency to slip upwards is counteracted by tapes passing from the lower end round the perineum, and tied to loops in the abdominal strap. The elastic bands have eyes which

fit over hooks on the celluloid cap or 'hat.' . . . The rim being curved, its edges do not indent the skin in any way. The urine escapes by two outlets, one on each side at the lower end of the apparatus, and passes through indiarubber tubing into a suitable urine bottle which rests in bed between the patient's legs. The lid is easily slipped on and off, and has a hole in the centre large enough to admit a No. 24 F catheter."

The wound is left open underneath the cap.

This admirable apparatus has been in use at the London Hospital for more than a year, and is found to save the time and expense of dressings, and to keep the patient absolutely dry. The bladder can be washed out through the hole in the top without wetting the patient, and the patient can lie on either side in comfort. The daily amount of urine passed can be estimated.

It should take the place of all other methods of dressing the wound. It is far superior to Colt's apparatus, which is most disappointing for practical purposes.

If for any reason Irving's dressing is impracticable the after-treatment becomes very tedious, and demands infinite care. The bed must be protected by mackintosh sheets, placed beneath the usual draw-sheets. A large cradle is spread across the pelvis. The care of the wound will demand the constant and undivided attention of a nurse.

The skin of the perineum, buttocks, and lower part of the abdomen should be kept as dry as possible, and should be smeared with lanoline to prevent the irritating effects of the contact of urine. Over the wound should be placed a large sponge, and above the sponge should be a large pad of absorbent wool, applied transversely, like a scarf, from one side of the groin to the other.

This pad rests upon the pubes. It keeps the sponge in place, and serves to absorb any urine which may escape the sponge. It may be conveniently replaced by pads of cyanide gauze, frequently changed.

Not less than twenty sponges should be in use.

The arrangement of the bed-clothes over the cradle allows the part to be always in view, the patient's trunk and limbs being well covered up with blankets.

The sponges and wool pad must be changed as often as needed—possibly two, three, or four times in the hour. The pad is of course thrown away, but the sponge can be used over and over again. Each sponge is well rinsed in water, is then immersed for some hours in carbolic lotion, is once more rinsed, and is then dried ready for use.

Before each sponge and scarf of wool are applied, the skin should be rapidly dried and covered with lanoline or benzoated lard. No bandage is required.

3. Median Perineal Lithotomy

Although not often performed by English-speaking surgeons now, this operation has a considerable vogue on the Continent. The indications for it, and its mortality, have already been referred to (pages 572 and 569). It is especially suitable for small hard calculi lodged in the pouched and dilated prostatic urethra; it is quite unsuited for large vesical stones. Its chief advantage over suprapubic lithotomy is that there is no risk of wounding the peritoneum; it is doubtful whether the perineal wound heals any more quickly than the other.

Instruments Required.—Grooved staff; pointed bistoury; Little's director or Teale's gorget; lithotomy forceps and scoop; sound; probe; pressure forceps; Clover's crutch, etc. The staff is a curved one, with the groove running along the middle of its under (convex) surface.

Preparatory Treatment.—This is represented by absolute rest in bed for a few days beforehand, during which time the bladder is washed out twice a day, and the kidneys are flushed out with copious drinking of bland fluids, and urinary antiseptics, such as urotropine or salol. It is most desirable to get the urine into as healthy a condition as possible before operating. This applies to all cutting operations on the bladder or urethra. Small doses of calomel to inhibit the growth of the colon bacillus

are also of value. It is most desirable that the rectum be empty. It should be ascertained that the whole of the enema has been returned.

Placing of the Patient in Position, and Introduction of the Staff.—The anæsthetic is administered, and as soon as the patient is insensible the anklets and wristbands may be applied. The patient is now brought down to the end of the table until the buttocks are projecting over the actual foot of the table. In this position, and while the legs are hanging towards the floor, the staff may be introduced. As soon as it is in place, the knees are very carefully brought up towards the chest, and the patient is fixed in the lithotomy position. It is very undesirable to introduce the staff while the patient is lying flat upon the table, and before any step has been taken to bring him into position. The rough movements necessary may cause the staff to damage the bladder or urethra. If the staff be introduced as above advised, all the rough movements are over, and nothing remains but gently to flex the thighs upon the pelvis.

The assistant who introduces the staff must not take his fingers off the instrument until it is finally removed from the bladder. The staff may be introduced after the patient has been placed in the lithotomy position, but the manœuvre is less easy to execute. When a Clover's crutch is used in place of the anklets, it is almost impossible.

The patient being in the well-known lithotomy position, the surgeon seats himself beyond the end of the table, his face being on a level with the patient's perineum.

Two assistants are required to support the legs, and it is their duty to see that the patient is kept immovable, that the median line of the perineum is exactly vertical, and that the knees are symmetrically separated.

A third assistant is responsible for the extremely important duty of holding the staff; and to the exact performance of this office he should devote his entire attention.

A fourth assistant may stand by the surgeon's side, to hand instruments, etc.

The presence of the stone should be verified by the staff or by a sound previously introduced.

The staff is held quite perpendicularly, and its concavity is drawn well up against the bony arch of the pubes. It is held rigidly and exactly in the median line. The assistant's thumb is placed upon the rough handle, while his fingers grasp the shaft. There must not be the least rotation of the instrument to one side or the other. In this position it is held throughout the operation and until it is withdrawn. The assistant at the same time holds up the penis and scrotum, and sees that the perineal raphe is exactly vertical.

The surgeon inserts the left index finger into the rectum, and steadies the staff with the point of the finger, which is pressed against it at the apex of the prostate.

The narrow bistoury is now thrust into the median raphe of the perineum half an inch in front of the anus. It is introduced horizontally, and with the cutting edge directly upwards. The groove in the staff is hit at the point where it is steadied by the finger in the rectum. The groove is entered at this point, and by continuing to thrust the knife deeper the apex of the prostate is slightly incised. The membranous urethra is cut through as the knife is being withdrawn, and the external wound is enlarged to the extent of about one inch by cutting upwards as the knife is being removed.

As the urethra is incised, the handle of the knife will be pointing almost directly downwards; as the integuments are divided, the handle will be pointing upwards. Special care must be taken to avoid wounding the bulb.

A Little's director, or a Teale's gorget, is now introduced along the groove of the staff into the bladder. It is held in the left hand. The staff is then withdrawn. Guided by the director, which is retained in position until the operation is complete, the operator gradually worms his right fore-finger into the bladder, dilating its orifice. The forceps are now introduced and the stone is withdrawn.

A rubber drain (without lateral openings) is introduced so

that one end projects just within the bladder. It is secured in this position by a silkworm-gut suture on either side of the small wound, which takes a hold of the tube. The latter is long, and is employed to drain the urine for a few days into a vessel suitably placed at the side of the patient's bed. The wound is dressed with moist sterile gauze packed round the tube and held in place by a T-bandage.

After-treatment in Median Lithotomy.—The patient is placed on a narrow bed with a firm horsehair mattress, protected by a waterproof sheet. Beneath the buttocks are kept squares of old sheeting, which can be changed as often as they are wetted with urine. In addition to the sheets, large sponges may be employed to absorb the escaping urine. They can be readily changed without disturbing the patient, they are easily cleansed, and if plenty are employed, and each one is allowed to lie for some time in a carbolic solution before it is used again, the same sponges can be employed over and over again. They need to be well dried by heat before being applied, and may be dusted with iodoform.

A rope and handle bar suspended above the bed will enable the patient to raise his pelvis readily when the squares of sheeting are changed. The knees should be supported by separate pillows, with an interval between them. Nothing must obstruct the free exposure of the tube.

If the escape of urine ceases, and there is pain about the bladder, the tube may be pushed a little further in, or a soft rubber catheter may be introduced through it into the bladder.

In most cases the tube may be removed in thirty-six or forty-eight hours. In some few instances—especially when there have been difficulties of micturition previous to the operation—the tube may have to be retained for three or four days, or even longer.

The parts exposed to the contact of urine should be dried as frequently as is possible. The scrotum should be kept away from the perineum by a simple suspender or "crutch pad." When the urine is alkaline and irritating, the skin of the buttocks

and perineum should be well smeared with vaseline and lanoline, after each change of the sheets or sponges. In cases of actually putrid urine the bladder should be washed out two or three times a day with a warm solution of boric acid. The urine begins to flow by the urethra as a rule between the eighth and twelfth day, and the perineal wound is generally healed and the patient "cured" within the month. The same care in the diet is observed as is customary after all major operations. If the bowels are not opened by the third day, a laxative should be given.

The following *complications* may occur during the after-treatment:—Retention of urine from blocking or displacement of the tube. Suppression of urine in cases in which the kidneys are diseased. Incrustation of the wound with phosphates may occur when the urine is ammoniacal and there is much cystitis. This is especially met with in aged and feeble patients. The condition is treated by frequent irrigation of the bladder with boric acid lotion or mildly acidulated solutions, and by constant attention to the wound. Epididymitis is very rarely met with after median lithotomy. Cellulitis from urinary infiltration is, of all the possible complications, one of the most serious. It is fortunately uncommon.

4. Treatment of Stone in Women

(1) In the case of quite small stones the urethra may be dilated, and the stone removed by suitable forceps.

The dilatation of the urethra is best accomplished by Hegar's uterine dilators while the patient is in lithotomy position and under an anæsthetic. The canal can soon be sufficiently dilated to admit the fore-finger, the amount of laceration is reduced to a minimum, and the subsequent incontinence is of short duration. The process of dilatation should be slowly carried out, and each dilator be introduced gently.

(2) In the case of larger stones, which could not be removed by the above method, the urethra should be dilated by Hegar's dilators until the canal will admit the fore-finger; a lithotrite

is then introduced, and the stone crushed at one sitting, the fragments being removed by a large evacuating catheter.

The comparatively large size to which the urethra may be dilated renders the operation of litholapaxy simple and efficacious. The pelvis should be well raised while the lithotrite is being used.

By this method stones up to the weight of one and a half or two ounces may be dealt with.

(3) The largest vesical calculi—those weighing three or more ounces—should be dealt with by suprapubic lithotomy.

In no operation upon the adult female for the removal of stone is it necessary to incise the neck of the bladder.

Vaginal lithotomy has been replaced by litholapaxy and suprapubic lithotomy.

It should be noted that a large proportion of the calculi met with in women are found round foreign bodies which have been introduced *per urethram*. For example, we have operated on a case in which a candle had been thus introduced, in another a thermometer, in another a large hair-pin, etc.

The removal of these foreign bodies may require great care to prevent damage to the bladder wall.

5. Removal of Tumours of the Bladder

Within recent years certain cases of vesical tumour have been very successfully dealt with by operation, and in many the procedure has been followed by complete cure. In instances in which the operation has been of necessity incomplete, or in which a rapid recurrence of the growth has supervened, considerable relief has usually been given to the patient, and the more distressing symptoms have been got rid of.

The method of treating vesical growths by deliberate operation was prominently brought before the notice of surgeons by Sir Henry Thompson, who in 1883 published an account of twelve cases so treated (*Med.-Chir. Trans.*, vol. lxvi., page 349).

Mr. E. Hurry Fenwick's monographs on the subject are noteworthy.

The suprapubic route alone gives proper access to the

tumour and enables its removal to be accomplished under the eye of the surgeon. Hence this method is now advocated, the perineal route being entirely abandoned. If possible, the size and position of the tumour should have been previously ascertained by means of the cystoscope. Unfortunately the hæmaturia which is the chief symptom of vesical growths renders such examination difficult.

Special Instruments Required.—Thompson's tumour forceps; long curved or bent uterine scissors; Fenwick's metal caissons of various sizes; long sponge-holding forceps; biting forceps; caisson forceps with removable handles; sharp hooks; square blunt hook for holding up bladder wall; electric head-lamp.

FIG. 147.—VILLOUS PAPILLOMA OF POSTERIOR WALL OF BLADDER WITH MUSCULAR HYPERTROPHY.

The Operation.—The pelvis being raised, the bladder is gently distended with sterilised water introduced through a rubber catheter. Through a median incision made immediately above the pubes the bladder wall is exposed and incised with the aid of the sharp hook. The incision should be small, and the index finger should at once be introduced to examine the growth, to ascertain its exact point of attachment, its degree of firmness, and the width of its base. In three out of four cases both of innocent and malignant tumours the attachment will be found in the region of the trigone, on the posterior wall. It is now necessary to introduce a speculum through the bladder wound, which may be enlarged with a bistoury for this purpose. The edges of the vesical wound are secured with two long silk sutures, which serve as retractors, or with a blunt hook. A vaginal speculum, or a metal caisson, is then introduced and all fluid mopped up with sponges, and the tumour inspected by means

of a head-lamp. In many cases the tumour can be dealt with through the speculum, which has the advantage of preventing access of urine during the manipulation. If, however, the base of the tumour is too broad for this, it is unsuitable for this form of operation, and can only be removed by some method which aims at excising the whole thickness of the wall of the bladder.

The growth, when exposed through the caisson and carefully examined by inspection, may be found to have a narrow pedicle, a broad pedicle, or be sessile. The last two conditions are evidence of malignancy, and unless the surgeon is prepared to excise part or whole of the bladder wall, nothing more can be done than removal of the projecting mass as a palliative measure. In the case of a villous tumour with a narrow stalk, not only must the stalk be removed, but also a considerable area of mucous membrane round the stalk, so as to diminish the likelihood of a recurrence. The chief difficulty is hæmorrhage.

Incision is made through the mucous membrane all round the pedicle half an inch away from it. A pair of narrow clutch forceps with curved lower ends is then applied round the pedicle beneath the mucous membrane, and the growth cut or twisted off beyond it.

If the pedicle be stout, it may be grasped and fixed close to the bladder wall by means of a pair of pressure forceps bent at a suitable angle. The neck is then grasped by a straight pair of pressure forceps at a little distance from the first pair, and is twisted off by rotating the instrument last introduced.

If the growth be very vascular, the main vessels running into it can be secured by catgut sutures which under-run them beneath the mucous membrane. Such ligatures are introduced by a curved needle before the tumour is excised (C. B. Lockwood). At the same time, the fewer ligatures left in the bladder the better, as they are apt to attract phosphatic concretion. To apply these sutures the caisson must be removed, and the base of the bladder brought up into the wound by a finger in the rectum.

If the growth have a broader base, it may, if it be well defined,

be transfixed close to the bladder wall by means of a rectangular needle in a handle, and be then ligatured with silk in two segments. The bent uterine scissors will be found useful.

Some of the softer and more diffused growths can be scraped away with the finger-nail, or with a curette or sharp spoon.

Others, of greater substance, can be removed piecemeal with Thompson's forceps (Fig. 148), and the resulting stump

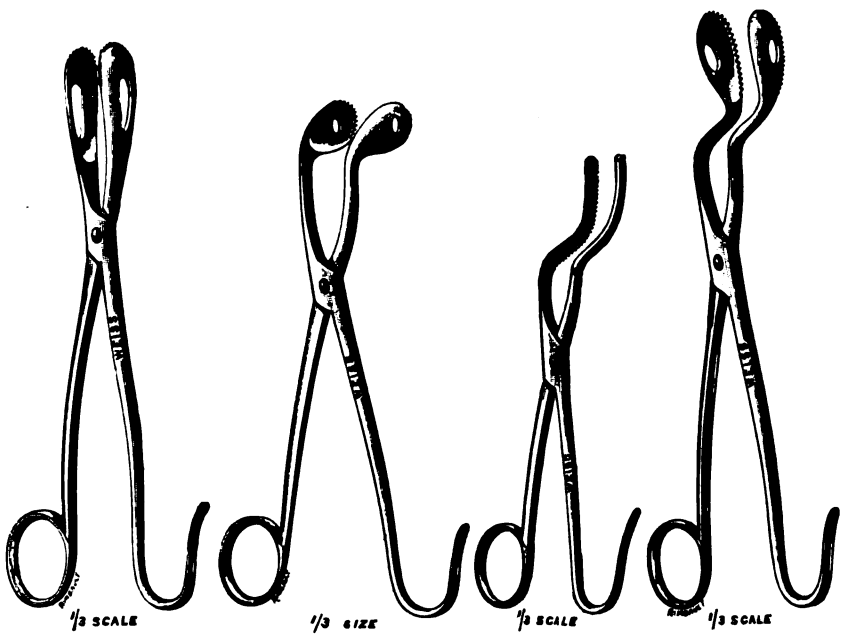


FIG. 148.—SIR HENRY THOMPSON'S VESICAL TUMOUR FORCEPS. (*Weiss.*)

then well scraped with Volkmann's spoon. This is the method which would be applied to epitheliomatous growths.

After the removal of extensive growths the bladder may be well rubbed out with a Turkey sponge, which will remove all detached or partly-detached fragments.

Hæmorrhage from the pedicle is the main danger of the operation. It is far more under control if the operation be performed with a caisson and head-lamp. The pedicle may be crushed or twisted before being cut, or it may even be

undersewn with catgut. Firm pressure with hot sponges, followed by pressure with a sponge soaked in adrenalin solution, will often check the bleeding. If it cannot be stopped by any of these measures a pair of bladder forceps, with removable handles, should be applied to the bleeding point through the caisson. The handles are then removed, the caisson slipped out, and the forceps left in for forty-eight hours. These forceps, as designed by Mr. Hurry Fenwick, are made by Weiss.

The patient is placed in bed with the foot-end raised on twelve-inch blocks, so as to lower the pressure in the pelvic vessels, and given injections of "ernutin."

If these measures are used, the bleeding will never prove serious.

The rectal bag should no longer be used. It has dangers of its own, and its pressure causes venous engorgement. Two fingers of an assistant introduced into the rectum will bring the growth more readily into view if found necessary.

The bladder should always be drained through the suprapubic opening, as it is almost impossible to stop all the bleeding, and there is less risk from the effects of the cystitis which usually follows the operation. If a very large opening has been made, it can be diminished by means of catgut sutures, taking up the muscular and outer coats only.

The after-treatment of the case is the same as is observed after suprapubic lithotomy and cystotomy.

6. Partial Resection of the Bladder

This operation is suitable for stalked malignant tumours or for small sessile tumours away from the trigone. Unfortunately, such cases are rare.

The bladder is explored by the suprapubic route. If the growth is in the anterior or lateral walls, the peritoneum need not be opened. If it is on the posterior wall, well above the trigone, the patient is shifted into the Trendelenburg position, the bladder dried out, the peritoneum opened in the middle line in front, and the intestines carefully packed off with

rolls of gauze, so as to leave the back of the bladder well exposed.

With a pair of scissors or a stout knife the bladder wall is cut clean through at the distance of an inch or more from the edge of the growth. Bleeding points are picked up and tied as the cuts are made. If one ureter is encroached upon, it is cut across an inch above the bladder, and the distal portion removed with the bladder wall. The proximal end is inserted afresh into another part of the bladder wound, care being taken not to narrow the ureteric opening by the sutures which fix it in place.

The wound in the bladder wall is sutured by a continuous catgut stitch which picks up all the coats except the mucous membrane. This is bound by a second layer of stitches. The peritoneum is stitched up after a peritoneal toilet. The bladder is drained through the original suprapubic extraperitoneal incision, and usually heals readily.

We have seen this operation yield brilliant results in properly selected cases. And the chance of recurrence after it is much less than after the usual intravesical operation.

7. Total Resection of the Bladder

This has been carried out with success in a fair number of cases. The ureters should be brought out on to the loin, as described above (page 552). The bladder is exposed by a T-shaped incision above the pubes, is not opened, but is shelled out of its bed extraperitoneally if possible, and its connection with the ureters, rectum, and membranous urethra secured. This operation is suitable chiefly for cases with multiple recurrent papillomata, which threaten the patient's life from loss of blood. For further details the reader is referred to Rovsing's paper (*see* page 552), and to a paper by Watson, *Annals of Surgery*, vol. xlii., page 805.

Growths of the female bladder can, in the great majority of instances, be dealt with through the urethra. The urethra is most conveniently dilated by means of Hegar's uterine dilators.

The process is rather slow, but it is satisfactory, and leads to the minimum amount of laceration of the part. After sufficient dilatation the finger can be introduced, and the growth examined.

Pedunculated tumours have been dragged sufficiently far forwards to enable a ligature or the loop of an *écraseur* to be applied to their pedicles.

Other tumours may be torn or bitten off with forceps, while the softer and more diffused growths may be scraped.

Larger and multiple vesical tumours are better dealt with through a suprapubic incision.

The **results** of operations for the removal of vesical growths may be said to be on the whole distinctly satisfactory. The period has not yet been reached when any substantial value can attach to the publication of statistics.

Dr. Stein's table, published in 1885, gave the general mortality of all operations for vesical growths as 39·8. Since 1885 the aspect of the operation has been much altered, and the mortality has been greatly reduced.

It may be said that while a certain number of cases are entirely cured, a large number show a recurrence of the growth, but that even in the worst cases the operation affords the patient very substantial relief and prolongs life.

CHAPTER XXI

RUPTURE OF THE BLADDER

THE successful treatment of rupture of the bladder by operation is of quite recent date, and may be said to date from the publication of the late Sir William MacCormac's cases in 1885. Previously to this time many surgeons had pointed out the importance of early operation, and valuable monographs on the symptoms, etc., had appeared by the late W. Rivington, C. Heath (*Med.-Chir. Trans.*, vol. lxii.), and others. But for some reason which is hard to find, no successful case of the operation had been recorded until MacCormac's two consecutive ones. The accident is so rare that the occurrence of two cases under the same surgeon in a short space of time, and both successful, is an example of the remarkable coincidences that are well known in surgery. Since 1885 the number of successful operations for rupture of the bladder has steadily grown, and must now amount to upwards of a hundred. Owing in part to the difficulty in early diagnosis the mortality is still high, though exact figures are almost impossible to obtain.

For example, Seldowitsch, in 1903, published the records of thirty-two cases of intraperitoneal rupture of the bladder treated by Russian surgeons. Fifteen were not operated on, and all these patients died; seventeen were operated on, but only four (*i.e.* 25 per cent.) recovered. On the other hand, an American surgeon, D. Fiske Jones, gives a far more favourable view (*Annals of Surgery*, February, 1903). He puts the mortality (*in published cases*) as over 60 per cent. before the year 1892, and under 30 per cent. since that date. He attributes the improvement to increased care in asepsis, especially as regards the use of the catheter and injections into the bladder in order to make the diagnosis certain.

Indications for Operation, etc.—The symptoms pointing to ruptured bladder in a patient who has sustained an injury (usually a fall or contusion of the abdomen at a time when the bladder was distended) are the following: 1. Sharp pain in the lower abdomen; 2. Fruitless desire to micturate; 3. Evacuation of blood-stained urine when a catheter has been passed—perhaps only after it has been pushed on gently into the rent in the bladder; 4. After an interval the onset of peritonitis (shown by hiccough, vomiting, rigidity of abdominal muscles, etc.).

It should be noted that aseptic urine does not readily or quickly produce peritonitis when extravasated, and that in some rare cases of extra- or sub-peritoneal rupture of the bladder a thick-walled cavity has formed around the extravasation without any suppuration occurring. Further, that the early symptoms of rupture are by no means constant—that, for example, the patient has been able to micturate naturally for two or three days after the bladder has given way (*e.g.* cases recorded by Stolper).

The rent in the bladder wall is usually vertical in direction, and situated high up on the posterior surface; this is fortunately the most accessible part for the surgeon. If the rupture were towards the base efficient suturing would be almost impossible.

One of us (J. H.) had to treat a case of perforation of the bladder in a woman, no doubt produced by an attempt at criminal abortion, in which the aperture was circular, small and near the trigone. As the post-mortem showed, it was absolutely impossible to have reached the perforation from above.

The linear rents through the posterior wall almost always involve the peritoneum, so that the urine at once escapes into the peritoneal cavity, although it may not cause peritonitis for many hours or even some days. Whether the rupture is intra- or extra-peritoneal it is of the utmost importance to operate without delay. The history of injury followed by frequent desire to micturate, the passage of small quantities of bloody urine, or the removal of larger amounts of the same by the catheter —these symptoms are amply sufficient to justify exploratory abdominal section, or at any rate careful examination under an

anæsthetic. In passing the catheter and in trying injections, etc., most scrupulous care should be taken as to asepsis. The hasty passage of a non-sterile catheter, or the neglect to clean the patient's meatus, etc., before its passage, may jeopardise the result of the whole operation by bringing on cystitis. The method of injecting eight or ten ounces of warm boric solution into the bladder, and measuring whether it all returns through the catheter, may be valuable in doubtful cases, but is not free from fallacy as regards the diagnosis of rupture. Moreover, if there is a rupture it is not desirable to inject more fluid into the peritoneal cavity. Usually the diagnosis can be made without it.

The prognosis largely depends upon the operation being performed before actual peritonitis has set in, although recovery may ensue even after this, and in spite of most unfavourable conditions. Thus, in a remarkable case reported by Messrs. Daily and Harrison (*Brit. Med. Journ.*, Jan. 10th, 1903), suture of the ruptured bladder was performed on the third day after the accident. The patient afterwards had uræmic delirium, and tore open his laparotomy wound so that the intestine prolapsed. A second operation was performed for this, and ended successfully.

The Operation.—The patient being in the usual position for laparotomy, and the pubic region being shaved and disinfected, the abdomen is opened in the median line.

The incision must be free, and in MacCormac's cases was six inches in length. Blood-stained urine and serum will probably escape as soon as the peritoneal cavity is opened. The depth of the wound should be exposed as well as is possible by means of strong rectangular retractors, and assistance may be obtained from a small electric lamp.

The posterior surface of the bladder is well exposed. The intestines are pushed upwards, and are kept out of the way by means of suitable sponges.

Search is made for the rent, which will most usually be found upon the posterior surface, midway between the summit

and the base of the viscus. If a catheter has been already introduced, it will be felt through the rupture. If the rent be low down in the bladder, some assistance may be derived from the use of the rectal bag, which will probably bring the parts better into view. In one case Sir W. MacCormac divided the parietal peritoneum transversely on either side of the bladder, and then found that the organ could be brought further towards the surface wound.

The parts having been well cleaned with a sponge, the sutures are at once introduced. They should be inserted by Lembert's method. The best suture material is fine sterilised silk, and each stitch is introduced by means of a curved needle, held in a needle-holder. The sutures must be applied closely: about four to the inch will suffice. In one of MacCormac's cases the rent measured four inches, and required sixteen sutures; in the other case the wound was two inches long, and twelve sutures were applied. The threads should include only the serous and muscular coats, and must on on account involve the mucous membrane. In tying the sutures, care must be taken that the edges of the wound are so inverted as to bring the two serous surfaces into even contact. It is well to begin the closure of the rent at its lowest point. The margins of the rent may perhaps be steadied by means of a blunt hook introduced into one end of the fissure. MacCormac advised that the sutures should be continued for some little way beyond the angles of the wound, in order to add to the length of infolded tissue and to strengthen the suture line.

When all the sutures have been tied, a warm boric solution should be injected into the bladder, in order to test the soundness of the seam. Any weak or suspicious spot in the suture line should be strengthened by the insertion of additional sutures.

The peritoneal cavity, and especially the pelvis, must now be thoroughly flushed out and sponged. Care must be taken that no sponges are left behind.

The parietal wound is then closed with sutures in the usual way.

If the rent in the bladder has been securely closed, and if the peritoneal cavity has been well flushed out, there is no need to employ a drainage tube in the parietal wound. It is, however, recommended by some that a strip of gauze should be inserted at one end of the wound.

There is also no need to drain the bladder, either by a perineal incision or by a retained catheter. MacCormac advised that the bladder should be left alone. If the patient cannot readily pass water, a soft catheter may be used as often as is required.

It has already been noted that occasionally in rupture of the bladder wall the peritoneum is not included in the tear. In such a case the operator would probably find the space above the bladder distended with urine—and he would endeavour to complete the operation extraperitoneally, first carefully suturing the peritoneum in the upper part of the wound.

Hildebrand (*Beiträge für klin. Chir.*, 1903) records a case of the ordinary intraperitoneal rupture which he first converted into an extraperitoneal one by sewing down the parietal layer to the back of the bladder below the rupture.

Such a manœuvre must be possible but very rarely, and we fail to see any special utility in it.

CHAPTER XXII

PLASTIC OPERATIONS UPON THE BLADDER AND URETHRA

THESE operations will be considered in the following order :—

1. Operations for Epispadias.
2. Operations for Hypospadias.
3. Operations for Ectopia Vesicæ.
4. Operations for acquired Urethral Fistula.

1. OPERATIONS FOR EPISPADIAS

This condition is less common than hypospadias, but at the same time causes much more inconvenience. It often exists as an isolated deformity, and quite independently of extroversion of the bladder, but all examples of the latter malformation are associated with epispadias.

There are various grades of the deformity, but the commonest condition is that known as the "complete form." In this the penis is much shortened and flattened, and is curved upwards towards the abdomen. It is compressed against the abdomen, and usually turns also to the left side. The funnel-shaped opening into the bladder may be of sufficient size to admit the finger. The prepuce is usually large, and depends like an apron. In the completer forms there is incontinence of urine, and great distress is occasioned by the continual escape of urine, and by the chafing and excoriation that follow.

It is noteworthy that after a successful operation, and often after one which is partly successful, some control is obtained over the bladder. The affection was at one time regarded as quite incurable. Attempts to form a new roof to the urethra by means of flaps derived from the lateral parts of the penis

failed. In 1852, Nélaton employed for the first time the method of reversed flaps, and since that date the treatment of this deformity has been placed upon a satisfactory basis.

Preliminary Measures.—In the section on the treatment of ectopia vesicæ an account is given of certain preliminary precautions which should be observed. To this account (page 616) the reader is referred.

In the last edition of this work a method of straightening or bringing down the stunted penis by subcutaneous division of the corpora cavernosa was described. We have now omitted this for the following reasons: (1) Complete division of both corpora cavernosa cannot be done without serious risk of wounding the corpus spongiosum and the urethra, thus causing a fistula or stricture; and (2) we do not believe division of the penis can result in any permanent and satisfactory increase in its length. If the band of fibrous and elastic tissue forming the suspensory ligament of the penis is found to hinder the descent of the penis it should certainly be divided.

In Nélaton's operation for epispadias, one of the flaps is obtained from the median line of the anterior abdominal parietes. The skin of this flap forms the new roof to the urethra. If hair grow from it, therefore, it will grow into the urethral passage, and serious inconvenience may follow.

Whether the operation is done in childhood, when the hairs are very scanty, or in adult life, it is certain that their growth on the under surface of the flap will cause trouble, and it is therefore essential to destroy all the hair bulbs before operating. Electrolysis is too tedious and painful a method, and one of the following will be as efficient and should be practically free from pain.

(1) A powder containing equal parts of sulphide of barium, oxide of zinc, and starch is made into a cream with water. This cream is applied for five or ten minutes to the surface and then removed.

An emollient ointment should be applied for a few days, and the application of the depilatory repeated if necessary.

(2) A few exposures to concentrated X-rays will probably suffice, but for young children this method is hardly applicable.

Nelaton's Operation.—This procedure dates from 1852. The penis, if not in good position, may be fixed by a thread passed through the prepuce.

(1) Two longitudinal incisions are made along the dorsum of the penis, one being placed on each side of the urethral groove. These incisions are parallel to one another and to the groove, and are placed a little externally to the outer margins of the groove.

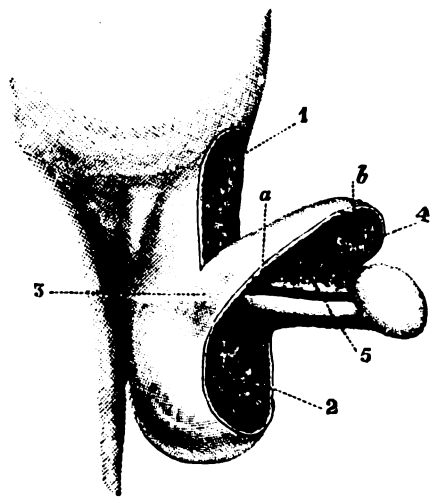


FIG. 149.—NÉLATON'S OPERATION FOR EPISPADIAS.

1, Raw surface left by abdominal flap; 2, Raw surface left by scrotal flap; 3, Pedicle of scrotal flap; 4, Scrotal flap; 5, Abdominal flap in position; *a b*, Free edge of penile flap, beneath which the margin of the abdominal flap has been introduced.

They terminate at the corona glandis by one extremity, and at the abdomen by the other. At each of these extremities of the two cuts two very short transverse incisions are made at right angles, and are directed outwards.

The minute and almost linear flaps thus marked out are dissected up as far as the lateral cuts will allow.

(2) The proximal ends of the two longitudinal incisions are now carried vertically upwards on to the abdomen, and are united superiorly by a transverse wound. The abdominal flap is thus marked out. Its breadth exceeds a little the width of the interval between the parallel penile incisions, and its length is a little in excess of the length of the urethral groove which is to be covered in (Fig. 149).

This narrow flap, when separated from the parts beneath, is turned down for the purpose of forming a roof to the urethra.

The skin surface lies towards the penis, while the raw surface is uppermost or external (Fig. 149). The edges are united by sutures to the raw edges left by the dissecting up of the minute penile flaps (*a*, *b*). The free, upper or transverse, border forms the upper margin of the new meatus. The union of this flap is so made that the edges which are brought together overlap a little, the minute penile flaps overlapping the margins of the abdominal flap. An extensive union is thus obtained.

It was found that if the operation were left at this stage the abdominal flap would by its contraction shorten the penis, curve it upwards, and gradually expose again more or less of the urethral groove.

To prevent this Nélaton made an additional flap from the scrotum as follows :—

(3) This flap is obtained from the anterior surface of the scrotum, and is limited by two curved incisions: the upper one circumscribes the under half of the penis, and follows the groove between the penis and the scrotum; the lower one is parallel to it, and is so placed that the length of the scrotal flap shall a little exceed the length of the penis. Both incisions are concave upwards. The flap is liberated, except at the sides, where is a wide pedicle (3, Fig. 149). The penis is then slipped under the flap, and its raw surface is attached by sutures to the raw surface of the abdominal flap which is already in position (5, Fig. 149).

The edges of the scrotal flap are united to the edges of the two penile flaps (*a b*, Fig. 149), and the operation is completed by closing in the raw surfaces (1 and 2, Fig. 149) left respectively upon the abdomen and scrotum.

After-treatment.—An indiarubber tube well oiled is placed in the new urethra and passed well into the bladder. It must be held in place by a couple of sutures. The wound surfaces should be well dusted with boric acid and covered with a light dry dressing. Dry and infrequent dressings are best suited to this class of case.

It may be possible to attach a long indiarubber pipe to the tube already in the urethra, and to allow the urine to drain away into a vessel under the bed. If this be attempted, a loop of the pipe must be attached to the bed cradle, so that the urethral tube cannot be drawn upon should the patient move in his sleep or turn over. The loop should give it sufficient play. If this cannot be arranged, the patient must sit as nearly upright as possible, and a mackintosh should be so arranged beneath him that the urine can easily drain away.

Constant care must be devoted to keeping the patient dry.

The bowels may be kept at rest for a few days.

In the case of a young child syrup of chloral may be cautiously given after the operation to keep the patient quiet.

A simple nutritious diet should be advised, and plenty of

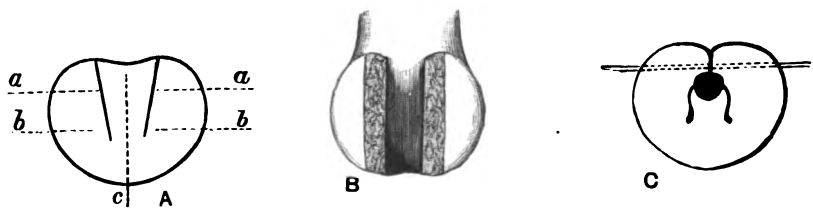


FIG. 150.—THIERSCH'S OPERATION FOR EPISPADIAS (FIRST STAGE).

fluid allowed, so that the urine may be as little irritating as possible.

The sutures will probably not be touched for eight or ten days. An anæsthetic may be necessary in order to carry out their removal safely.

The tube in the urethra may be removed in five or seven days, or less. If it excite undue irritation, or if urine escape by the side of it, it may be taken out earlier.

Result.—This operation has been fairly successful. The patient's condition is much improved, but two objections have to be noted: first, the glans remains uncovered; and, second, the new urethra is abnormally large. By means of Thiersch's operation an attempt is made to close the urethra without leaving these defects.

Thiersch's Operation.—This operation was described by Thiersch in 1869 (*Archiv f. Heilkunde*, 1869, Hft. I.). It has been adopted by many surgeons with excellent results. The procedure is divided into four stages.

First Stage.—Formation of a meatus and that part of the urethra which occupies the glans.

A deep incision (*a a*, Fig. 150, A) is made in the glans along each side of the urethral groove. These two incisions converge a little below and involve about three-fourths of the thickness of the glans.

They serve to separate the dorsal part of the glans into three parts—a median and two lateral (*c*, *b b*, Fig. 150, A).

The surface of the outer lip of each incision is pared for its entire length (Fig. 150, B), and while the median portion is depressed by means of a short length of catheter which is introduced, the two lateral portions are brought together, and are united by means of fine silkworm-gut sutures in the median line (Fig. 150, C).

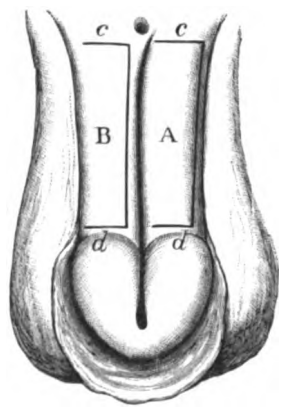


FIG. 151.—THIERSCH'S OPERATION FOR EPISPADIAS (SECOND STAGE).

The middle segment carries with it the whole of the mucous membrane, and its surface is, therefore, not disposed to unite with the raw surface, which at first forms the roof of the new urethra.

Second Stage.—The formation of the penile urethra. When the wound in the glans has healed, and the sutures have been removed, and when the urethral canal in the glans has been well established, the second step in the operation is undertaken.

An incision is made through the skin and subcutaneous tissues on the dorsum of the penis, on both sides of the urethral groove. The incision on the right side (Fig. 151, B) is made close to the urethral groove. The incision on the left is placed about half an inch from the left margin of the groove (Fig. 151, A).

The two cuts are parallel to one another. By means of the transverse incisions (*c c*, *d d*) two long narrow flaps are marked out. The right flap (B) has its free edge abutting on the urethral groove, while the left flap (A) has its base in that position. (*See* also Fig. 152, 1.)

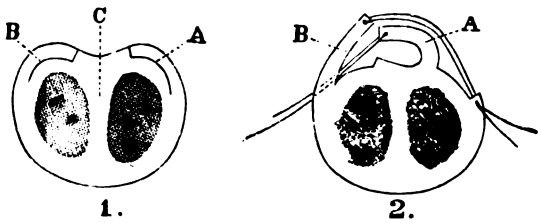


FIG. 152.—THIERSCH'S OPERATION FOR EPISPADIAS (SECOND STAGE).

The two flaps are then dissected up, and are made as thick as possible.

The left flap (Fig. 152, A) is now turned over to form the roof of the new channel, its raw surface being uppermost. A row of sutures is passed through it, near to its free margin, in the manner shown in Fig. 152, 2, and Fig. 154, and the sutures are then made to pass through the base of the right flap (B). They are finally secured by shot or quill attachment (Fig. 152, 2, and Fig. 153). The left flap (Fig. 153, A) thus forms the roof of the new urethra, while the right flap (B) covers over the raw surface of the left flap. The free edge of the right or surface flap is secured to the left side by a series of simple sutures, as shown in Fig. 152, 2, and Fig. 153.

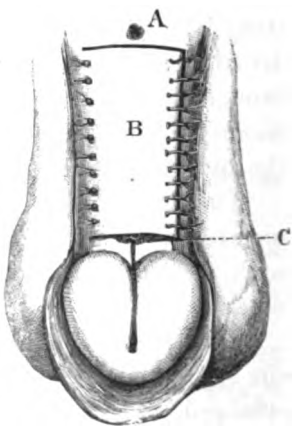


FIG. 153.—THIERSCH'S OPERATION FOR EPISPADIAS (SECOND STAGE COMPLETED).

A tube, which has been already introduced along the whole length of the urethra, from the meatus to the bladder, is retained, if necessary, until the wounds have closed.

When this stage is completed, and the incisions have entirely healed, the third step is undertaken.

Third Stage.—The covering-in of the small gap (Fig. 153, C)

left in the roof of the urethra between the glans and the body of the penis.

To effect this the apron-like fold of the imperfect prepuce is made use of. This piece of skin is stretched, and a transverse button-hole incision is made in it. Through this slit the glans is slipped.

That part of the pendulous prepuce which was lowest now becomes uppermost.

The margins of the glans and of the skin on the dorsum of the penis which bound the little gap are freshened, the ring of the displaced prepuce is interposed between them, and the raw edges, or surfaces, thus brought together, are united by sutures (Fig. 154). Another long interval is allowed for recovery.

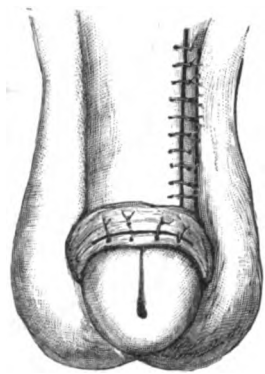


FIG. 154.—THIERSCH'S OPERATION FOR EPISPADIAS (THIRD STAGE).

Fourth Stage.—The closure of the funnel-shaped opening which leads into the bladder.

Two flaps are employed for this purpose, and one is taken from each inguinal region.

The flap taken from the left side is of triangular shape (Fig. 155, A), its base corresponding to the left half of the upper circumference of the bladder orifice. It is turned downwards, with the raw surface outermost, and is secured to the freshened margin of the skin forming the roof of the new penile urethra (Fig. 155). The right flap is long and quadrilateral, and has its base in the inguinal region, parallel to Poupart's ligament (Fig. 156, B).

It is placed over the raw surface of the left flap, and is fixed by sutures to this flap, to the skin to the left of the base of the same flap, and to the freshened area which surrounds the upper border of the bladder orifice (Fig. 156).

Comment.—If a proper interval be allowed between each stage, the operation will extend over some months.

The operation may fail at one stage, and may need to be repeated.

Thiersch at first established a perineal fistula as a preliminary measure, in order that the course of the urine might be diverted during the period covered by the operations, but subsequent experience has shown that such a step is not necessary.

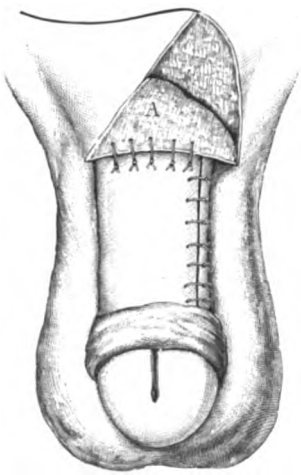


FIG. 155.—THIERSCH'S OPERATION FOR EPISPADIAS (FOURTH STAGE).

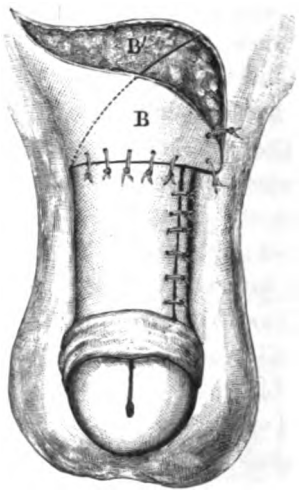


FIG. 156.—THIERSCH'S OPERATION FOR EPISPADIAS (FOURTH STAGE).

In the *slightest forms of epispadias* there is no incontinence, and the deformity causes no trouble, but the appearance of the penis may be considerably improved by transplanting the redundant prepuce in the manner described in the third stage of Thiersch's operation.

2. Operations for Hypospadias

This, the commonest of all the malformations of the urethra, has been the subject of a very large number of more or less complicated operations.

The varieties of the deformity are classified according to the position of the opening of the urethra. In front of the opening the urinary passage is either entirely absent or is represented by a groove, or by a partly pervious canal.

1. *Balanitic.*—The opening is here at the site of the corona, the frænum is absent, and a hood-like prepuce exists.

2. *Penile.*—The urethra may open at any part of the under-surface of the penis, and if the opening be far back nearly the whole of the penile urethra will be wanting, so far as its floor is concerned.

3. *Scrotal.*—Here the opening is either at the junction of the penis and scrotum (peno-scrotal), or is on the perineal side of the scrotum (perineo-scrotal).

In all but the slighter cases the penis is small and deformed. It may be attached to the scrotum by a cutaneous web, or be held in a curved position by a fibrous band upon its under-surface, which represents the undeveloped urethra and the capsule of the corpora cavernosa. In extreme cases of curving of the penis the glans is forced against the scrotum, and only the dorsum of the shortened penis is visible.

Purpose of Operative Treatment.—There is very rarely any incontinence with hypospadias, and in common cases of slight degree no serious inconvenience is complained of. The main difficulties depend upon the arching of the penis, and the existence of an opening far back. The curving of the penis renders micturition difficult and coitus impossible. Every time the patient makes water the scrotum and the perineum are wetted with urine, and, if care be not constantly taken, these parts may become eczematous. The urethral opening may also be so narrowed by the curving of the penis that micturition is seriously impeded.

If any operation be carried out, it should be made in child-hood. If the deformity can be corrected early, the penis may not improbably, as growth proceeds, assume a very fair degree of development.

If the condition has been left untreated until the patient has reached adult life, it had better be left altogether. In such a case the man will have learnt how to overcome the difficulties of micturition. The penis, if it could be straightened (and it is not always possible at a late period), would be found

to be short, wasted, and stunted. In these cases the testes are not uncommonly found to be small and atrophied, and the patient's sexual instincts are only slightly developed.

In the balanitic form of hypospadias an operation can seldom be called for, and the deviation from the normal condition may be so slight as not to cause any appreciable inconvenience.

Attempts to make a new urethra through the glans by perforating that structure with a trocar (Dupuytren) are quite unjustifiable.

The accepted operations for hypospadias have in view two objects: (1) the correction of the malposition of the penis, and (2) the restoration of the canal of the deficient urethra.

(1) The malposition of the penis may be corrected by means of one or more transverse incisions which divide the band of contracted tissue passing between the glans and the hypospadic opening. To overcome the curving of the penis completely it may be necessary to carry the incision deeply into the substance of the corpora cavernosa. It is usually better to effect this division through an open wound, the integumentary edges of which are united subsequently by sutures.

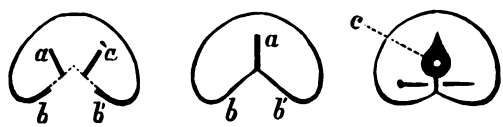


FIG. 157.—DUPLAY'S OPERATION FOR HYPOSPADIAS.

Before proceeding further with the treatment of the case, some six or eight months should be allowed to elapse, in order that it may be made evident that the correction of the false position has been permanent.

(2) The restoration of the canal may be effected by one or other of the following operations.

Duplay's Operation.—*First Stage.*—The penis is straightened.

Second Stage.—A new meatus is formed. This is effected by freshening at their lower parts the two lips (*b b'*, Fig. 157) of the depression which represents the meatus, and by placing between these two lips a small catheter tip (*c*, Fig. 157), over

which the freshened surfaces are united by several points of suture. If the depression be too shallow to permit the formation of a large enough meatus, two small lateral incisions (*a a'*, Fig. 157), or a median incision (*a*), made in the substance of the glans, will render it possible to introduce the tip of a catheter of proper size.

This part of the operation may be carried out at the same time that the penis is straightened, and the duration of the treatment be thus shortened.

Third Stage.—The new canal is formed.

On the lower surface of the penis, on each side of the median line, and some millimetres outside of this line, a longitudinal incision, *a b*, *a' b'*, is made, extending from the base of the glans to within 1 cm. or even ½ cm. of the hypospadic opening (*c*, Fig. 158).

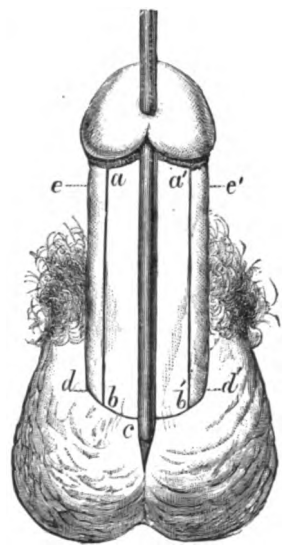


FIG. 158.—DUPLAY'S OPERATION FOR HYPOSPADIAS.

The internal lip of the incision is now slightly dissected up, so that the narrow strip of skin between the wound and the median groove may be inclined inwards as a species of flap (the so-called inner flap) over the catheter, but without attempting to cover it entirely. On the other hand, the outer lip of each incision is to be dissected up freely, so as to draw towards the median line the skin of the lateral parts of the penis, *e d*, *e' d'*. This skin is brought forward in the form of a loose flap (the so-called external flap). The cutaneous surface of the inner flaps is thus turned towards the cavity of the canal, whilst their raw surface is turned towards the outside, and is covered by the raw surface of the two external flaps. Although the catheter is thus not wholly covered by a cutaneous surface, Duplay has found no inconvenience to result from that circumstance.

The displaced flaps are now united in the median line by

means of a quilled suture. Very fine silver wire is used; each suture is made of a single wire, and is separated from its fellows by a distance of ½ cm. The ends of each wire are passed through holes made in small leaden tubes, and are fastened by perforated shot (Fig. 159).

If the surfaces approximated by this suture leave a little separation externally, union is completed by a few superficial points of interrupted suture (Fig. 159).

Fourth Stage.—The two parts of the canal are united.

The margins of the openings to be approximated are fresh-

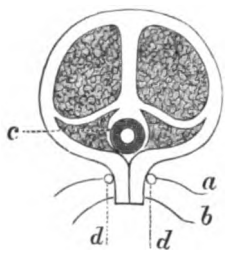


FIG. 159.—DUPLAY'S OPERATION FOR HYPOSPADIAS.

a, Deep sutures; *b*, Surface sutures; *c*, Catheter; *d*, Leaden tubes or quills.

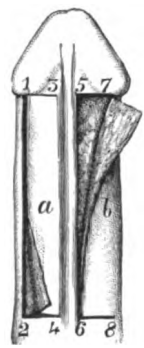


FIG. 160. — ANGER'S OPERATION FOR HYPOSPADIAS.

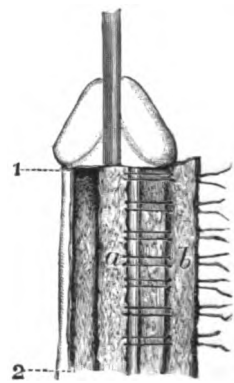


FIG. 161.—ANGER'S OPERATION FOR HYPOSPADIAS.

ened, and the raw edges are then drawn together and united—over a catheter—by means of a deep quilled suture and some interrupted superficial sutures.

The catheter is retained during all stages of the operation until healing is assured.

An interval of some months should be allowed to elapse between the third stage of the operation and the fourth.

Anger's Operation.—The operation, as here described, does not include the formation of a meatus. It is assumed that the penis has been straightened.

An incision (1 2, Fig. 160) is made on the right side of the penis from the glans to the scrotum, and half an inch from the

median line. The transverse cuts, 1 3, 2 4, serve to make out a flap (*a*, Fig. 160). This flap is dissected up and has its base along the median line. A second longitudinal incision, 5 6, is made to follow the left margin of the urethral groove. Two transverse cuts, 5 7, 6 8, about an inch in length, are made at each extremity of it. A flap (*b*, Fig. 160), with its free margin bounding the urethral groove, is thus marked out.

It is dissected up, and will possess at least double the width of the right flap (*a*).

A catheter having been introduced into the bladder, the first flap *a* is turned over so that its cutaneous surface covers the catheter (Fig. 161). Sutures are then passed as follows: Very fine silver or silkworm gut is used. To each end of the suture a slender needle is threaded. Each needle is made to transfix the free margin of the first flap *a* from the skin surface to the raw surface. The loop will be on the cutaneous surface. Both ends of each suture (*i.e.* both needles) are then made to transfix the base or outer part of the left flap (*b*, Fig. 161), and in the cutaneous surface of that flap they are secured by shot (Fig. 162, s).

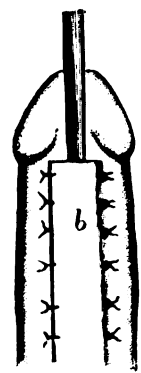


FIG. 162. — ANGER'S OPERATION FOR HYPOSPADIAS.

The left flap (Fig. 161, *b*) is drawn to the right so as to cover the raw surface of the first flap (*a*), and the free edge of this more superficial flap is then united by interrupted sutures (Fig. 162, w) to the raw border left by the incision 1 2, Figs. 160 and 161.

Other Operations have been devised, but they call for no very full description. An account of *Szymanowski's* most ingenious but not very practical operation will be found conveniently summarised in Stephen Smith's "Operative Surgery." *Professor Wood* and others have made use of the redundant prepuce (which is usually present in hypospadias) to close in the canal, in whole or in part. This can be most conveniently carried out when the urethra is wanting to the extent of its anterior half only. When the deformity extends as far back as

the scrotum, the late Professor Wood supplemented the flap taken from the prepuce by a flap cut from the front of the scrotum.

Wood's method of arranging the preputial flap is as follows :— A transverse buttonhole incision is made in the prepuce close to the coronal groove on the dorsum. The glans is slipped through the aperture made. Two lateral flaps are dissected up from the penis upon either side of the urethral groove, and, being reversed, are turned over, so that the skin surface is towards the new canal. These flaps are united by a continuous suture of fine catgut. The transposed dorsal prepuce is then "split up into two layers at the cut edge, which is opened and spread out over the raw surface of the reversed urethral flaps, and stitched to the edges by closely applied sutures of fine silver wire" (Heath's "Dictionary of Surgery," vol. i., "Hypospadias").

Comment. — In criticising this operation, it may be pointed out that the integument of the prepuce and scrotum is not well adapted to form the tissue of a primary flap. It is not readily handled, and the lax subcutaneous layer renders œdema a troublesome complication. The prepuce may serve a useful purpose in assisting to close a small defect and in supplementing a more extensive operation, but it has not yielded satisfactory results when used to form the principal flap.

From Mr. Wood's account it is to be inferred that the lateral, or urethral, flaps are united in the median line, and to this practice also some exception may be taken.

3. Operations for Ectopia Vesicæ

Condition of the Patient.—Ectopia is more frequently met with in males than in females, in the proportion of ten to one. It is invariably associated with epispadias. When the urine is ejected in a decided jet on coughing or crying, some dilatation of the ureters is indicated.

The scrotum is wide and shallow, as a rule, and the testes are often in the groin. An oblique inguinal hernia often exists on one side or on both sides. The perineum is shorter and

wider than normal, and the pubes are separated to the extent of from one to six inches.

The pubic symphysis is thus always absent, and where it should be projects the red swollen posterior wall of the bladder, on which can be generally found the two ureteric openings. The condition will be understood from Fig. 163. The patient in this case happened to be a girl, contrary to rule.

The patients are often feeble and sickly. Renal disease, in the form of surgical kidney, is not uncommonly present,

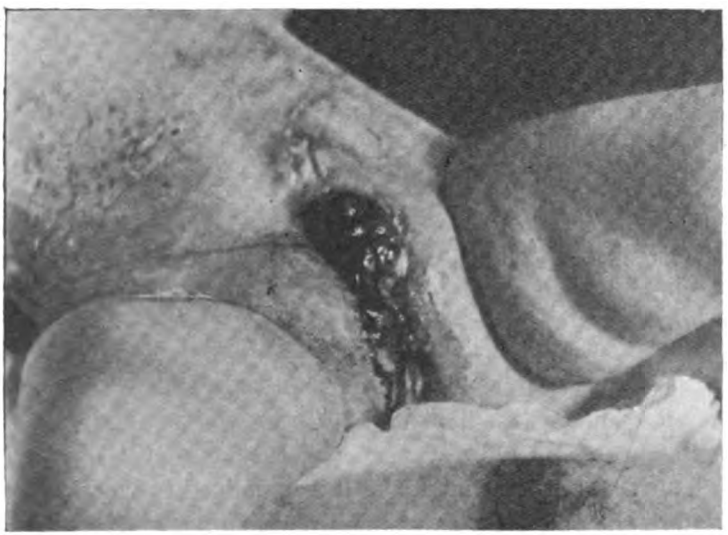


FIG. 163.—ECTOPIA VESICÆ IN A FEMALE CHILD.
Above the protruding wall of the bladder are seen scars of an unsuccessful plastic operation.

especially in the older patients. It is a frequent cause of failure and of death after operation.

Patients with ectopia have, however, lived to reach old age without having undergone treatment of any kind. Thus, H. S. Newland (*Brit. Med. Journ.*, April 28th, 1906) records the case of a man with complete ectopia who made his living by stone-breaking, and who lived to be sixty, ultimately dying of cancer of the exposed bladder surface.

As a rule the distress caused by this deformity is great.

The urine is constantly dribbling away. The thighs, scrotum, perineum, and abdomen are wet with urine and excoriated. Ammoniacal decomposition of the urine with the incontinence causes such a nuisance that the boy becomes a social pariah. A well-fitting urinal will render the condition fairly tolerable.

Age for Operation and Preparatory Treatment.—Operative treatment may be commenced when the patient is four or five years of age. It should in any case be undertaken and completed before puberty.

FIG. 164.—ECTOPIA VESICÆ.

The posterior wall of the bladder, with the openings of the two ureters, is to be seen.

The treatment will extend over many months, and will usually occupy more than a year.

During this period the patient will be subjected to many operations. In a case quoted by Billroth the treatment occupied twenty-two months, during which time nineteen operations were performed. This experience is not exceptional, and in a patient seen by one of us (J. H.), with severe epispadias amounting almost to ectopia, twenty-five operations had been performed at various hospitals! Though improved, the urethra in this case was still open on its dorsal surface, and the patient still was obliged to wear a urinal.

Before the operation is commenced it is most important that the patient be in good health. There should be no cough, the bowels should be acting normally, the urine should be healthy and not irritating, and the skin as free from inflammation and eczema as is possible. The cystitis also must be dealt with. Much can be done by frequent bathing, and by soaking up the urine by pads of compressed cotton wool which have been impregnated with corrosive sublimate. To keep a patient dry by these means will require the unremitting attention of a nurse night and day.

In order that the patient may be in the best condition, a long rest in the recumbent position is desirable, during which

time much may be done by constant irrigation and unremitting attention to get both skin and mucous membrane into a healthy condition.

When a reversed flap is employed, and the integumentary surface is turned in towards the bladder, some trouble may result from the *growth of hair* from the displaced skin. The hair, if it attain any length, may block up the new urethra, and may lead to an accumulation of phosphatic concretions and other complications. Its growth is most likely to give trouble when well-developed hair is already growing upon the flap, as may be the case in an adult. When, however, the operation is carried out in very young subjects, the growth of hair seems to be subdued altogether. In other instances in which the hair has continued to grow it has been observed that the growth has declined in vigour as time went on, and that it has ultimately ceased entirely.

In cases where the hair at the time of the operation is unduly abundant, it is best to remove it by some depilatory, such as barium sulphide (*see* page 601). When this is being applied, the skin and exposed mucous membrane must be carefully protected by a mixture of olive oil and chalk applied in a thick layer. No operation would be attempted until the skin thus treated was quite healthy.

Methods of Operating.—The very numerous operations advised or adopted in cases of ectopia vesicæ may be divided into three classes :—

(1) Operations designed to divert the urinary passages.

(2) Operations for closing in the defect by means of flaps.

(3) Operations for narrowing the defective area by approximating the two innominate bones.

(1) TRANSPLANTATION OF BOTH URETERS INTO THE RECTUM

Since the first attempt in this direction made by the late John Simon in 1852, a great variety of methods have been devised. The object of all of them is to divert the flow of urine

into either the sigmoid flexure or the rectum, where a cloaca is formed capable perhaps of holding the urine for some few hours. Of course the patient subsequently micturates through the anus. It should be mentioned that the ureters have also been transplanted on to the skin of the loins; but a double urinary fistula in the back must be a far worse condition than that of ectopia vesicæ, and the proceeding must be condemned.

We may also reject all methods of high transplantation of the ureters—*i.e.* into the sigmoid flexure—because they give no better—possibly worse—results than those involving the rectum; whilst there is the additional and grave risk of contamination of the peritoneal cavity. The preference should be given without hesitation to the extraperitoneal operation, which, we believe, was first described by Prof. G. A. Peters, of Toronto (*Brit. Med. Journ.*, June 22nd, 1901), from whose paper Figs. 165 and 166 are taken. A successful case, operated on by the same method, has been reported by Mr. H. S. Newland, of Adelaide (*Brit. Med. Journ.*, April 28th, 1906), and others have been published.

The Operation.—The intestine has been thoroughly cleared by aperients. A sponge attached to a long silk thread is passed high up into the rectum; this serves a double purpose, as it pushes the rectal wall forward and keeps it empty. Each ureter opening is then defined on the surface of the bladder protrusion, and a small circular rosette of mucous membrane shaped with scalpel and scissors around it. A rubber catheter (the blunt end of which is cut off) has been passed into each ureter, and each is now secured to the opening by a single silk suture. Care must be taken in fixing this suture through the bladder wall and that of the catheter not to narrow the lumen of the latter. The catheter should be the largest that can be introduced, but will, of course, only be of small size. By blunt dissection, aided by the scissors, the lower inch or so of each ureter is separated. The surgeon's finger is now introduced into the rectum, and a point on its lateral wall is selected as high up as convenient. A narrow pair of forceps is made to project

at this point from the rectum; a small incision from in front through the rectal wall enables the forceps to come through. With it the catheter on the corresponding side is drawn into the rectum, carrying with it the ureter and surrounding rosette

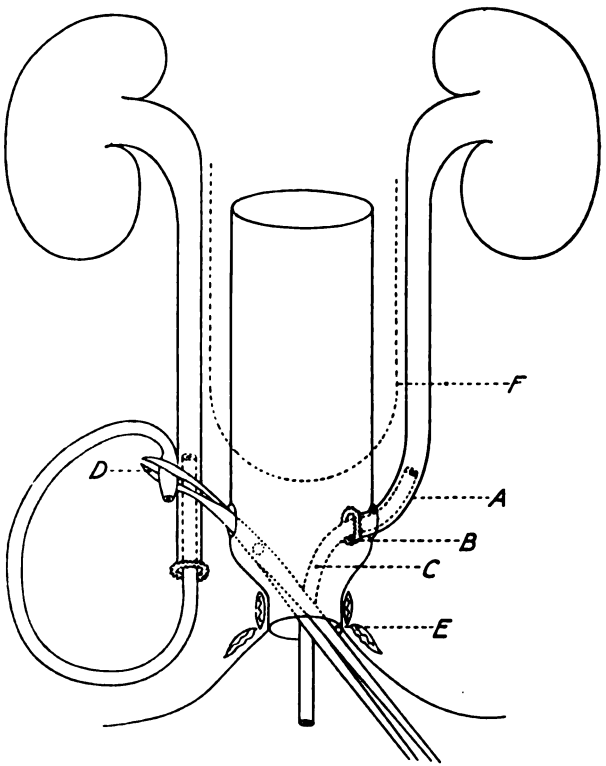


FIG. 165.—PETERS'S METHOD OF TRANSPLANTATION OF THE URETERS. (*Brit. Med. Journ.*, June 22nd, 1901.)

A, End of ureter which is dissected free, and in which a catheter (C) is inserted and fixed by a suture at B; D, Forceps passed through rectal wall in order to grasp and draw through the catheter and ureter; E, Sphincter ani; F, Reflexion of peritoneum.

of bladder wall. (*See* Fig. 165.) Precisely the same manœuvre is carried out on the other side. Both catheters now project from the anus, and the ureteric ends will remain just within the wall of the rectum. Prof. Peters states that there is no necessity for fixing them there by sutures, provided the openings have

been made sufficiently high up to avoid tension. In his case he then proceeded to dissect away from in front all the projecting part of the bladder, taking every care not to open the peritoneum. No subsequent plastic operation was required. Of course, the surgeon may prefer to leave the dissection of the vesical wall for a later operation.

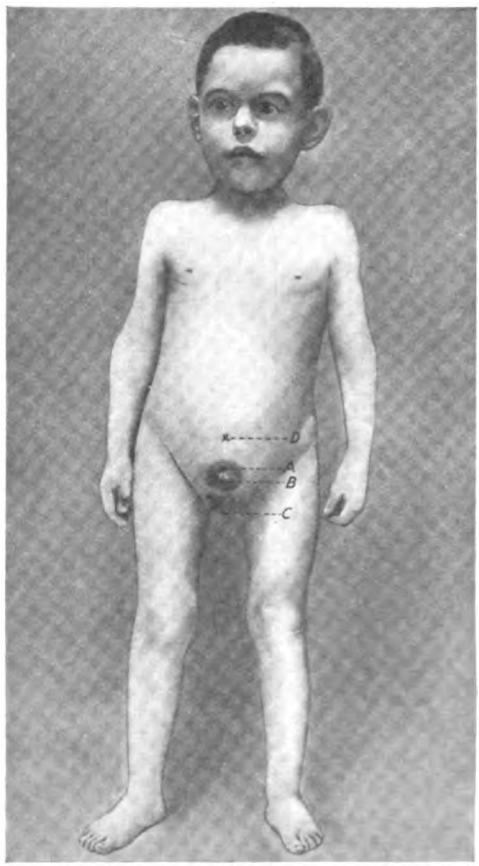


FIG. 166.—RESULT OF PETERS'S OPERATION (18 months afterwards).

A B, Scar in position of former ectopia vesicæ, with rudimentary penis; C, Anus; D, Umbilicus.

Comment.—The results in reported cases of extraperitoneal transplantation have been so favourable (*see*, for example, Fig. 166, taken from Peters's case eighteen months later), that we believe it will be given an extensive trial in preference to the complicated and, on the whole, disappointing methods of closing in the bladder by flaps, etc.

One would think that the constant presence of urine in the rectum would prove irritating and set up proctitis, but this does not seem to be the case, nor does there seem to be any frequent desire to empty the rectum in these patients. One drawback and possible risk must be mentioned—namely, ascending pyelitis, which apparently is due to infection from the

Bacillus coli. Still, as occurred in more than one of the recorded cases, an attack of pyelitis has developed after the operation, and has been recovered from. It would seem worth while to give the patient urotropine, or a similar urinary antiseptic, for the two or three months following the operation.

There are several other ways of performing transplantation of the ureters into the rectum, but they possess no advantage over the one described above. In the *Annals of Surgery*, 1906, page 237, and reproduced in Jacobson's "Operative Surgery," will be found an account of a case of Mr. Moynihan's in which "the whole of the bladder wall" was turned round and transplanted into a gap made in the front of the rectum. The figures accompanying this account give, we think, a very imperfect idea of the operation. The method almost certainly involves opening the peritoneal cavity, and has no compensating advantage. The same must be said of several other methods, devised by Continental surgeons. If transplantation of the ureters is carried out, the best method is Peters's. If a piece of the ectopic bladder of any size is cut free and implanted into the rectal wall, it must be reversed, and this will twist the ureters; moreover, if the transplanted part does not actually slough from want of its blood supply, it is sure to atrophy.

(2) OPERATIONS FOR CLOSING IN THE DEFECTS BY MEANS OF FLAPS

The early flap operations were more or less uniformly unsuccessful. Attempts to close in the opening by definite flaps were made as far back as 1844. The flaps were not reversed, and failure followed.

Reversed flaps were first employed by Roux, Richard, and Pancoast.

Roux (*L'Union Méd.*, 1853) dissected one flap from the abdomen above, and another from the scrotum below, and united them in a reversed manner over the exposed bladder, so that the raw surfaces were turned outwards. Both flaps sloughed.

Richard (*Gaz. Hebdom.*, vol. i., 1854), following the lines of Nélaton's

operation for epispadias, attempted a like operation a little later, but with a fatal result.

Dr. Ayres, of New York, operated upon an adult female in 1858 ("Congenital Exstrophy of the Urinary Bladder," New York, 1859) by turning down a flap of skin from the abdomen over the bladder. The cutaneous surface of this flap was turned towards the bladder. Its raw surface was covered by a process of gliding. The result was not very encouraging.

Dr. Pancoast, of Philadelphia (*North Amer. Med. and Chir. Review*, July, 1859), carried out an operation in the same year (1858) which proved to be more successful.

Two lateral flaps were dissected up on either side of the defect, and were turned over so as to cover the bladder (their cutaneous surfaces being innermost). The flaps were reversed, but not superimposed. Union took place between the edges of the flaps.

Mr. Holmes first employed reversed and superimposed flaps with success in England, in 1863 ("Surgical Treatment of Children's Diseases," 2nd edition, page 149).

From these early operations the present more successful procedures have been derived.

The two principal methods now in use are known as—

A. Wood's operation.

B. Thiersch's operation.

These may be regarded as two standard procedures, founded upon different principles, and forming the bases for many modifications.

A. **Wood's Operation.**—Here three flaps are formed—a reversed upper or umbilical flap, and two lateral transplanted flaps, which are made to cover the upper flap. The following description is derived from the late Prof. Wood's account in Heath's "Dictionary of Surgery," 1887.

(*a*) *The Cutting of the Flaps.*—The upper flap (Fig. 167, C) should be figured by a line extending along the side of the bladder surface vertically upwards as far as the measured distance from the root of the penis to the upper margin of the bladder, and then carried in a rounded curve across the "linea

alba " at this point to join another vertical line of equal length on the opposite side of the bladder.

The two groin flaps (Fig. 167, A, B) for superposition are to be made of a rounded lancet shape, with the roots downwards and inwards at the base of the scrotum, and continued along the side of the urethral groove for about half its length. These flaps should be long enough and detached enough to meet in the median line for their whole length, and no sharp angles should be left in their outline. The incision for making them should join that of the lateral border of the first or umbilical flap at about its centre.

In raising the umbilical flap care must be taken not to make the skin too thin, which is apt to be done in the centre of its base near the upper margin of the bladder. The tissues are here so thin that there is danger of wounding the peritoneum.

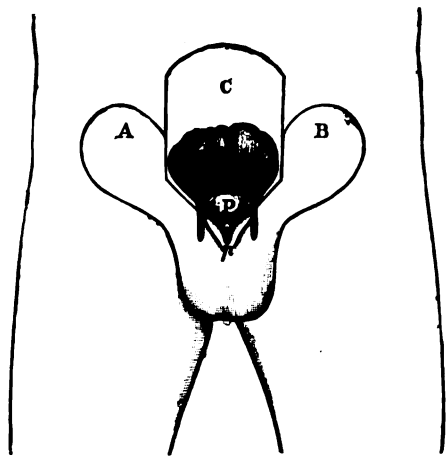


FIG. 167.—WOOD'S OPERATION FOR ECTOPIA VESICÆ.
A B, Lateral flaps; C, Upper flap; P, Prostate; *p*, Penis.

The flaps should be handled with the fingers rather than with forceps. In raising the lateral flaps the superficial external pudic arteries are cut and may need to be ligatured. All bleeding must have been checked and all clots removed before the flaps are placed in position.

(*b*) *The Adjusting of the Flaps.*—The upper flap is folded evenly down with its skin surface to the bladder, and is attached by sutures (Professor Wood used silver wire) to the cut edge at the root of the penis on each side.

The groin flaps are then placed upon the raw surface of the umbilical flap. Their inner edges are united by sutures in the

median line, and their bases should closely embrace the root of the penis. The raw surface left by the removal of the umbilical flap is closed by drawing the edges together with hare-lip pins. The surfaces left in the groin were in Professor Wood's first operation treated in the same way, but he advised later that the upper borders of the groin flaps should be held upwards by one or two wire sutures, and that the raw surfaces which remain should be left to heal by granulation (Fig. 168).

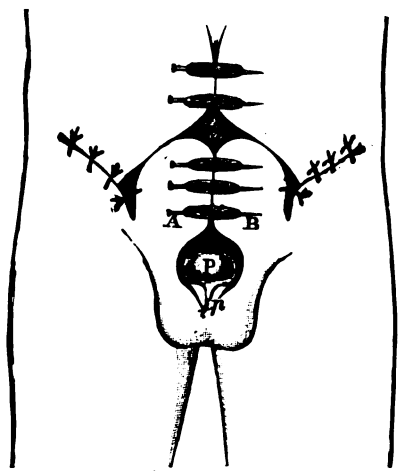


FIG. 168.—WOOD'S OPERATION FOR ECTOPIA VESICÆ.

A B, Lateral flaps; C, Upper flap; P, Prostate; *p*, Penis.

In the Female the umbilical flap should be large, and the incision for the groin flaps on each side should be carried well down, so as to have their roots in great measure connected with the labia. When the flaps are finally sutured together, the vagina should be almost closed up by them, with but a small opening to allow the passage of the urine. (*See* Mr. Mayo Robson's modification of the operation, page 626.)

(*c*) *Treatment of the Epispadias.*—This is effected by Nélaton's operation modified to meet the altered condition of the parts above the opening into the bladder. (*See* page 602.) In the place of the abdominal flap there described an incision is made parallel to and half an inch above the arched cicatrised urethral border of the covering of the bladder, and the integument thus marked out is then turned down in the form of a fold, with the skin surface directed towards the upper surface of the penis.

With this exception the operation follows the lines already indicated.

Comment.—This operation meets successfully the two great difficulties which attended early procedures.

i. In these cases a sinus was left at the site of the umbilicus which it was found almost impossible to close.

Such a result may be certainly expected if lateral flaps are employed in the fresh state without reversion or without the addition of the umbilical flap.

ii. The constant pressure upon the posterior wall of the bladder had in the early cases a tendency to cause a protrusion as the cicatrices contracted. As a result of this the opening above the penis became larger and larger. This difficulty is met partly by groin flaps of considerable size, which closely embrace the root of the penis, and partly by means of the scrotal flap, which prevents the tissues about the opening from being drawn up as cicatrisation and contraction proceed. The scrotal flap is an essential feature in dealing with the epispadias.

During the progress of the operation warm sterile water should alone be employed. In dissecting up the lateral flaps great care must be taken in cases where inguinal herniæ exist.

If it be possible so to fashion the pedicles of the inguinal flaps that the external pudic arteries are not divided, a great point is gained.

Modifications of Wood's Operation.—The late Mr. Greig Smith (*Brit. Med. Journ.*, February, 1880) made the flaps of a little larger size. The umbilical flap is in shape like the wooden portion of a fire-bellows. The portion corresponding to the handle of the bellows is uppermost and in the median line, and when the flap is turned down this portion is used to cover in the urethra, and to afford a further attachment to the tissues dissected up from the penis and scrotum.

The umbilical flap and the lateral flaps are secured together by means of deep quilled sutures applied in a vertical line over about the middle of each lateral flap.

Mr. Smith reports two cases, in both of which an excellent result was obtained.

Mr. Mayo Robson (*Brit. Med. Journ.*, Jan. 31st, 1885) reported a very successful case of Wood's operation carried out in a female child aged eight years.

Allusion has been already made to the difficulty which arises in this procedure, of preventing some reopening of the sinus, owing to the retraction of the flaps which cover in the bladder. In Mr. Robson's case this retraction caused the bladder surface to be once more exposed in part. To meet this complication, Mr. Robson so detached the folds of integument constituting the labia majora as to form on each side of the median line two triangular flaps which were capable of being displaced upwards. The upper margins of these flaps were attached to the lower margins of the flaps already in position.

By this means the bladder surface was entirely covered in, and only a small slit was left for the escape of the urine. This procedure should be always carried out in operating upon the female subject by Wood's method. Some excellent drawings illustrate Mr. Robson's paper.

B. **Thiersch's Operation.**—Two lateral flaps are formed, one to cover the lower half of the defect, and the other the upper half (*Zentralblatt für Chir.*, 1876, page 504). Each flap when first cut is large enough alone to cover the whole of the exposed area. From the nature of the method adopted, allowance has to be made for the shrinking of the flap. The flap first made is intended for the lower half of the bladder. It is marked out by two incisions. One commences at the upper margin of the defect, and proceeds downwards to the root of the penis, round the margin of the bladder. The second is placed at a suitable distance to the outer side of the first, is parallel to it, and is continued down to Poupart's ligament. The flap is detached in the form of a strip or bridge, and is left connected with the body by its upper and its lower extremities. Beneath it is placed a plate of tinfoil or ivory, and for a period of three weeks its under surface is allowed to granulate. At the end of three weeks the upper attachment of the flap is divided, and it is laid transversely over the lower part of the defect. The margin of the defect will have been freshened, and to this raw border the flap is attached. The granulating surface of the flap is turned towards the bladder. (The use of granulating flaps

in plastic surgery is dealt with in the second volume of the present work.)

When this flap has soundly healed, and has become safely fixed in its new situation, the second flap is cut from the other side of the defect (Fig. 169).

It is fashioned in exactly the same way, though the two parallel incisions do not extend so low down, but end at the place of attachment of the first flap. As this flap is to be of the same size as the first, the two incisions will have to be carried higher up on the belly. The bridge of skin thus marked out and separated is allowed, as before, to granulate for three weeks. At the end of this time its upper end is divided, and it is placed transversely over the upper half of the defect. Its granulating surface is turned towards the bladder, and its margins are united to the margins of the defect, which will have been freshened to receive it.

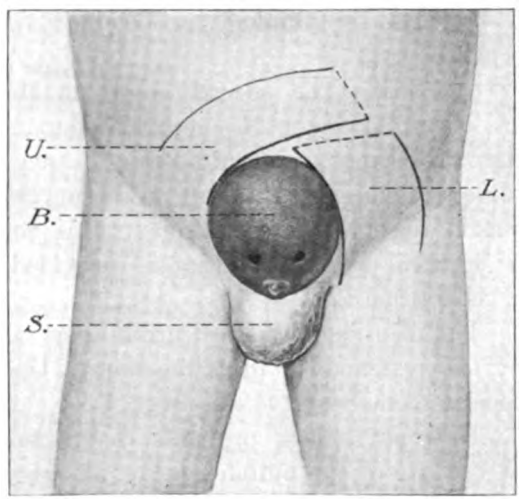


FIG. 169.—THIERSCH'S METHOD BY DOUBLE FLAPS.

B, Posterior wall of bladder, showing the ureteric openings; S, Scrotum; U, Long flap or bridge to be reversed over the bladder after division at the dotted line; L, Shorter flap to be subsequently slid in front of the reversed flap (U), again with division of one end at the dotted line.

The interval between the two flaps will now be indicated by a transverse line. When the second flap is securely united, the contiguous margins of the two flaps at this line are freshened, and are secured together by sutures.

Finally, the upper margin of the second flap and the adjacent (superior) margin of the defect are freshened, and are united by sutures. If the tissues of the abdominal wall at the upper

margin of the defective area be too thin for sutures, then an attempt is made to secure the closure of this final gap by granulation. When the bladder has been covered in, the epispadias is dealt with by Thiersch's method, the details of which have been already described.

The treatment involved by this method will extend over twelve or eighteen months, and will necessitate a great number of separate operations.

The results obtained by Thiersch appear to have been excellent.

Comment.—The special points in this admirable operation are the following :—No umbilical flap is used, on the grounds that its tissues are often so thin, scanty, and ill-nourished that some sloughing of the flap is not uncommon, and also for the reason that in the dissection of this flap the peritoneum may be injured, and a condition is provided for the production of a ventral hernia.

The injurious action of urine upon raw surfaces is prevented by the system of granulating flaps. Upon the granulating surface it seems to have no effect.

It would appear probable that a sinus would often be left at the site of the umbilicus, but in practice this has not proved to be the case.

The flaps are not used until their vitality has been tested, until their capability of sustaining what may be termed a partly independent existence has been proved, and until they have undergone considerable contraction.

Thiersch's operation has on the whole decided advantages over Wood's method, and in its principles it is more fully in accord with those of modern plastic surgery.

(3) OPERATIONS FOR NARROWING THE DEFECTIVE AREA BY APPROXIMATING THE TWO INNOMINATE BONES

Professor Trendelenburg, of Bonn (*Zentralblatt für Chir.*, December, 1885), is the originator of this method of treatment. He relates his experience of it in the *Annals of Surgery*, 1906, page 281.

It is well known that in ectopia vesicæ the symphysis pubis is deficient, and that a gap exists between the two pubic bones, which, according to Wood, may measure from two to four inches or more. Trendelenburg divides the sacro-iliac synchondrosis on either side, and finds that it is then possible to bring the two pubic bones together by slight pressure. The lateral margins of the defect are freshened, and are brought together when the bones are approximated. Immediate union of the wound is aimed at. The results obtained by this operation have been striking and in a sense satisfactory.

In one case failure occurred at the first operation, but success attended the second attempt at closure. In two instances, immediate union of the lateral walls was obtained. In only one case had the formation of flaps to be resorted to. An excellent account of the operation, with a successful case, has been given by Mr. Makins in the *Med.-Chir. Trans.* for 1888.

Best Age for the Operation.—Trendelenburg considers that the operation should be limited to a period between the ages of two and eight years. In the case of failure above alluded to the patient was only fourteen months old.

The Operation.—The distances between the anterior superior iliac spines and between the two pubic bones having been recorded, the patient is anæsthetised, and is turned upon the face. An incision is made directly over each sacro-iliac synchondrosis. The average length of this incision will be about three inches. The posterior sacro-iliac ligaments are exposed, and freely divided. The knife is then passed into the cleft, and the interosseous and superior ligaments, together with the interarticular cartilage, are severed. The bleeding is trifling. The anterior superior iliac spines are now approximated, and the joints will then be found to gape posteriorly to such an extent as to allow the introduction of the forefinger. The two wounds are then closed, and a drain introduced, if necessary. A suitable dressing is applied.

Extension of the joints is provided for by Mr. Makins in the following way :—

The patient is placed in a cot, and a pelvic belt on which three loops of strong webbing have been sewn is applied to the anterior borders of the pelvis. These loops are crossed as a many-tailed bandage, and are carried over the opposite side of the cot, where weights are attached to them. These weights tend to draw the ilia together.

Very great care has to be taken to prevent urine from trickling down and reaching the wounds over the articulations.

When the wounds are healed, the attempt to close in the bladder may be made.

In Mr. Makins's case nearly two months were allowed to elapse between the division of the synchondrosis and the attempt to close the defect in the bladder. By this time the exposed surface of the bladder appeared at the bottom of a more or less narrow vertical groove.

The margins of the defect are freshened and dissected up, and are mobilised as far as is required. They are then approximated by sutures in the median line. A tube is introduced into the bladder, and is retained there.

Comment.—The advantages and disadvantages of the operation are fully dealt with in Mr. Makins's paper.

It is claimed for this measure that it is simple, that it effects a great saving of time, that it may possibly be completed in two operations, and that it is very satisfactory in its results. All these points must be allowed, and the operation must take a high position among the methods available for ectopia vesicæ.

The main objection urged against the operation is that it tends to weaken the pelvis. It is well known that the pelvis in these cases is defective, and that the waddling gait of the patient is to some extent due to the deformity of this part of the skeleton. The symphysis pubis is wanting, the ossa innominata do not come into contact in front, and to divide the posterior and almost only remaining connections of the bones would appear to prepare the way for serious weakening of the pelvic girdle. Up to the present time, however, this theoretical objection has not been found to hold good in practice. The

patients operated upon have walked well after the period of convalescence was passed.

It must be allowed that although the posterior synchondroses are opened up, yet the anterior synchondrosis is to some extent restored, and the rotation of the ilia, which is a feature of these cases, is overcome.

The value of the operation can only be tested by time.

It must be remembered that the operation can only be carried out in young patients, and in female subjects it is possible that an undesirable degree of narrowing of the pelvis may result. The extent to which the joints are freed must depend upon the needs of the case. The partial separation effected in Mr. Makins's case allowed the anterior superior iliac spines to be approximated one inch in a boy aged eight. With complete freeing of the joints Trendelenburg has lessened the distance between the two spines by two inches in a child aged two and a half years.

Such entire rupture of the connection between the ilium and the sacrum should be limited to extreme cases.

In speaking of Prof. Trendelenburg's operation it must be noted that according to his account of his most successful cases (three in number)—

(i) Retention of urine was not complete in any of them. "These young men, therefore, wear a contrivance supplied with a small spring which compresses the root of the penis."

(ii) It appears to be impossible permanently to unite the pubic bones together—*i.e.* to create a symphysis, although the distance between them may be narrowed.

(iii) The final result is not materially better than that obtained by successful flap operations, but probably the number of separate operations required is considerably diminished.

(iv) Prof. Trendelenburg believes that surgeons will again abandon rectal transplantation of the ureters owing to its attendant risk of pyelo-nephritis.

At present we think that transplantation of the ureters according to Peters's method offers the best chance of success.

AFTER-TREATMENT OF CASES OF ECTOPIA VESICÆ

After any plastic operation every care must be taken to prevent the urine from coming in contact with the wound.

To effect this end, the patient should be propped up in bed in a sitting posture, the shoulders must be well raised, a thick pillow must be placed under the knees, and the thighs should be kept drawn up by means of a bandage which passes under the knees and across the shoulders and back.

The bed should be provided with a proper mackintosh, and with such a mattress that the urine can escape through a funnel-shaped opening in the centre of the bed.

Troublesome erections may be controlled by the application of ice.

The bladder should be frequently washed out with a warm solution of boric acid, and the tube placed in the urethra should be frequently changed.

Special care will be needed to prevent the formation of bed-sores.

Mr. Parker kept his patients in a hip-bath of warm boric lotion throughout the whole of the after-treatment, with the result that almost complete primary union followed a flap operation. With care the position of the patient in a hip-bath may be made so comfortable that he will rest better in the bath than in the constrained and cramped position he must of necessity occupy in bed. The discomfort of lying upon a wet mackintosh is also not inconsiderable. It is needless to say that the lotion in the bath must be maintained at an even temperature, and be constantly changed.

Thiersch and others advise the use of a compressorium after the operation has been quite completed. This instrument is intended to occlude the newly made urethra, and to be removed when required.

It cannot be recommended, on these grounds: In the first place, the capacity of the new bladder is very small;

and in the second place, the constant pressure of the instrument is capable of producing a slough, or even a urinary fistula.

Even in the most successful cases a urinal cannot be dispensed with.

RESULTS OF THE OPERATION GENERALLY

The results claimed in the most successful cases are that the raw surface of the bladder is protected and covered in, and that a urinal can be worn which will keep the patient quite dry. Many patients are free from the inconvenience of incontinence when they are lying down, but in no instance can it be claimed that the patient has acquired a control over the bladder. These results, however, are very satisfactory when the miserable condition of the patients before operation is considered.

In placing the circumstances of operative treatment before the patient's friends, the following facts must receive due consideration :—1. Patients with ectopia have reached old age, and have had no operation performed. 2. It may still be possible to secure an apparatus which will protect the bladder and efficiently collect the urine. 3. The treatment is tedious and painful, and may extend over many months, or over some years. In one case, treated by the late Professor Billroth, no fewer than nineteen operations were performed. 4. The operative treatment is not without risk.

We should imagine that few operations in surgery are attended with a larger percentage of partial or complete failures than are the flap operations for extroversion of the bladder.

The mortality of the various operations is impossible to estimate, as few surgeons have experience of more than two or three cases. But it is certain that pneumonia, nephritis, and other complications following operation have caused many deaths. This is a very important consideration.

4. Operations for Acquired Urethral Fistula

The remaining operations upon the urethra consist almost exclusively of various methods which have been adopted for the purpose of closing acquired urethral fistulæ. These operations involve no special feature of plastic surgery, and will only be very briefly alluded to. The principal difficulty in effecting a closure of these fistulæ depends upon the fact that the wound is apt to be saturated with urine every time the patient empties the bladder. If this difficulty can be met, the treatment of the sinuses becomes comparatively simple.

It must be assumed, in the first place, that the cause of the fistula has been dealt with. In a very large proportion of cases the sinus has followed upon stricture, and it is needless to say that no treatment of the fistula will be of avail until the stricture has been cured. Assuming, then, that the parts have been placed in the best possible condition for healing, the difficulty incidental to the passage of the urine can be most effectually met by establishing a perineal fistula through such an incision as would be made in median or lateral cystotomy.

Through such a wound the whole of the urinary current can be diverted if a suitable tube be retained in the bladder during the healing process. The ease with which such incisions close as soon as the urine is allowed to escape once more by the urethra is well known.

If there be any objection raised to the incurring of such small risks as attend a simple cut made into the bladder, then the surgeon must attempt to close the fistula while the urine is still passing by the natural channel.

In any such case a soft catheter must be introduced into the bladder, and must be retained there until the wound has healed. To the end of this catheter must be attached a long tube with a free lumen, whereby the urine as soon as it enters the bladder can be conducted directly to a vessel placed beneath the patient's bed.

If moderate good fortune attend the case, such a catheter

may comfortably be retained for a week, and at the end of that time it may be withdrawn, the urethra washed out with some mild antiseptic solution, and a fresh instrument, if necessary, introduced. In some instances, for one reason or another, the catheter cannot be retained. Very often it excites catarrh of the bladder or urethra, and a muco-purulent discharge escapes at the meatus. In these cases it is of little avail to persist in attempts to close the fistula, and the least risk and the least inconvenience to the patient are involved in at once establishing a temporary opening at the neck of the bladder.

The skin of the penis is not very well adapted for plastic measures. It has the advantage of being mobile, but it is at the same time very thin, and not capable of an active granulating process.

The **operations** which may be carried out in these cases are the following :—

(1) The margins of the fistula may be freshened, and directly united by sutures. Any tension upon the sutures may be met either by means of lateral incisions or by freely mobilising the integument all round the seat of the abnormal opening. It should be remembered that the cause of the fistula persisting lies in the aperture in the urethral wall itself. Once this is firmly closed union is easy to obtain in the soft parts over it. Now the penile urethra will bear isolation well without risk of necrosis, hence we advise that it should be thoroughly exposed by careful dissection, a catheter forming the guide to the surgeon, for at least half an inch on either side of the actual opening. The roof of the urethra is certain to be intact, and need not be interfered with as a rule ; the ragged edge of the opening should be refreshed, and fine catgut sutures should be placed in the wall to sew it up securely at the lower part of the urethral circumference. If this cannot be effected neatly over the catheter without undue tension by mobilisation of this part of the urethra, then it is best to resect the fistulous portion and make an end-to-end approximation. The sutures should involve as little of the actual mucous lining as possible.

(2) The fistula may be closed by the process known as the method of gliding or lateral displacement.

(3) The closure may be effected by means of flaps, which may be single or double, lateral or antero-posterior.

The formation of a pedunculated flap, adjusted by means of torsion, is not well adapted for this part of the body.

The use of one reversed and two superimposed flaps has been attended with considerable success.

The general plan of such an operation is identical with that of Nélaton's operation for epispadias (page 602).

A long narrow median flap may be dissected up from the tissues immediately behind or in front of the fistula. The base of the flap would correspond with the posterior or anterior margin of the fistula. The flap is raised and is reversed, so that its skin surface is turned towards the urethra. It is attached to the freshened margins of the defect. Over it two lateral flaps are drawn, so as to cover its raw surface and further to strengthen the shield which is made to protect the breach. These lateral flaps will be united to one another in the median line.

It will be obvious that this last-mentioned measure is susceptible of considerable variation and modification. In connection with this subject the section on hypospadias (page 608) may be consulted.

CHAPTER XXIII

OPERATIVE TREATMENT OF STRICTURE OF THE URETHRA

CASES of stricture at or close to the meatus, which are quite exceptional, should be treated by incision with a blunt-pointed bistoury or tenotome, followed by the regular passage of a large-sized bougie (if possible, No. 25 French). In every other case of stricture the treatment by gradual dilatation with flexible bougies should be tried. Only when this fails—either from impermeability to the instruments, from extreme resiliency of the stricture or irritability of the urethra—should an operation be resorted to. The best operation, provided that a fine bougie can be introduced as a guide, is unquestionably internal urethrotomy. If no bougie, however small, can be passed through the stricture, the operator may be obliged to perform Wheelhouse's operation (page 645). Finally, he may be compelled in the worst and most neglected cases to make an artificial opening into the perineal urethra without attempting to cure the stricture (Cock's

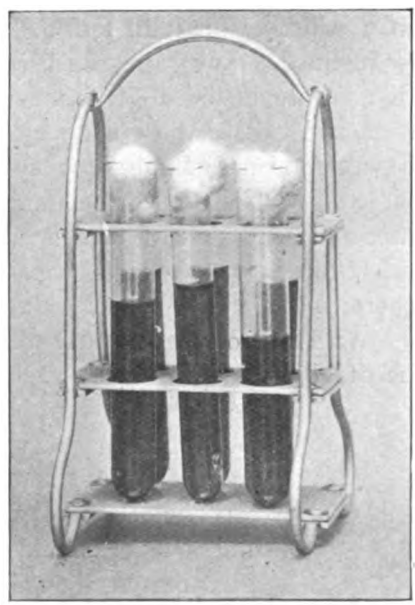


FIG. 170.—METAL STAND WITH TUBES OF STERILISED OIL FOR USE IN CATHETERISATION. EACH TUBE IS PLUGGED WITH WOOL.

operation). It will be seen that internal urethrotomy is reserved for a small percentage of cases (those in which gradual dilatation fails), whilst external urethrotomy should be regarded as the last resort of the surgeon, though it should be noted that some surgeons do not so regard external urethrotomy, and perform it in preference to the internal operation. The former, however, is certainly attended with greater risk, and always causes a fistula for a time, occasionally for months or years. Convalescence from internal urethrotomy, on the other hand, is a matter of a week or two.

It has been claimed for external urethrotomy that the chances of a permanent cure (*i.e.* without involving the subsequent use of bougies) are greater than after the internal operation or than after gradual dilatation.* It is doubtful if such a claim is justified. Now and then it happens after either method that no tendency to subsequent contraction of the stricture is shown, but in the great majority of cases the patient should be urged to pass a fair-sized flexible bougie at regular intervals for long afterwards. The danger of allowing any patient to use a rigid or metal instrument need not be emphasised; it is certain to lead to a false passage being made; it is nothing short of criminal.

With regard to **gradual dilatation** a few words may not be out of place.

1. The greatest care should be taken as to asepsis. Before passing any bougie or catheter, the meatus and glans penis should be thoroughly cleansed with carbolic lotion or other antiseptic, and the bougies and syringe should be perfectly clean. Partly for this reason, bougies should always be used in preference to catheters for dilating a stricture.
2. The patient's urine should be kept in as healthy a condition as possible. Regular living, avoidance of alcohol, and the internal use of urotropin or salol

* For example, Mr. F. T. Paul writes:—"The only permanent cure for most cases of stricture is external urethrotomy."

(twenty to thirty grains a day) should be enjoined whilst the treatment is being carried on.

3. The best bougies are those made with the distal half more flexible and tapering than the proximal end. The flexibility of the former almost prevents the risk of making false passages, whilst the firmness of the latter is a great advantage in manipulation. They should be graduated on the French scale (in millimetres of circumference).
4. The pain or discomfort of having a stricture dilated is lessened by the injection and retention for several minutes of a solution of eucaine, novocaine, or cocaine (4 per cent.). Internal urethrotomy may be done under one of these local anæsthetics, but it is generally advisable to give ether, etc.
5. In gradual dilatation, as soon as a size is reached when the bougie is tightly gripped, it should be left in from fifteen to thirty minutes, and then an attempt made to pass a larger size, but without using force. It is important not to cause any material pain or bleeding, to rest the urethra for a day or two—in a word, to make haste slowly.

INTERNAL URETHROTOMY

Although this operation is most successful in properly selected and prepared cases, yet it has sometimes been followed by grave results. Amongst these may be mentioned fatal hæmorrhage from wound of the dorsal vein of the penis, suppression of urine following severe rigors, and pyæmia or septicæmia. These results ought never to occur, provided the following rules are carried out :—

1. The urethral wall should not be incised deeply in the middle line towards the pubes, but should be slightly notched on either side, so as to get the same effect with two superficial cuts as with one deep one.

2. The operation should never be undertaken whilst the urine is in an unhealthy condition (*i.e.* containing pus or quantities of micro-organisms). This point is of great importance.
3. The patient should be prepared as carefully for this as for any other operation; he should have had light diet, no stimulants, an aperient, and twenty-four hours' complete rest beforehand.

A great variety of urethrotomes have been devised, but Teevan's modification of Maisonneuve's instrument (Fig. 171) is perhaps the best. In this the knife-blade is made to divide the stricture from in front, Teevan's improvement consisting in a guide bougie of fine calibre, which is screwed on to the end

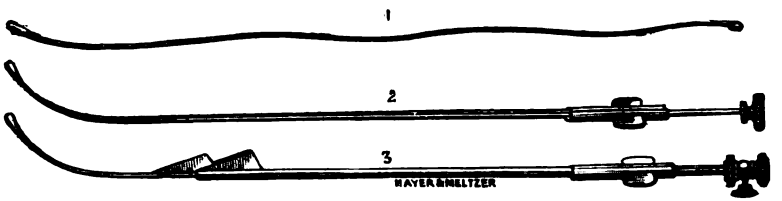


FIG. 171.—TEEVAN'S URETHROTOME.

1, Bougie to act as guide; 2, Fine staff and stiletto; 3, The complete instrument with knife-blade protruded.

of the urethrotome, and is passed on into the bladder. Before use, the instrument should be carefully examined, so as to avoid the risk of the bougie breaking off, etc. The guide bougie must be flexible, and yet with sufficient rigidity to enable the stricture to be passed.

The urethral canal is straightened by the surgeon making traction with the left hand whilst the bougie is introduced. If the stricture be very tight, the instrument is apt to double back, in which case another bougie should be tried. As soon as there is no doubt it has entered the bladder, the urethrotome is screwed on to the bougie, and both are well oiled, the instrument being then passed onwards until the knob of the urethrotome presses against the stricture. The urethrotome is depressed so that its handle lies between the patient's thighs. The knife-

blade is then made to protrude one or two millimetres from its guard, and the stricture divided on either side of the median line. After each cut of the knife, the latter is withdrawn within its guard. When it is thought that the stricture is sufficiently cut, the urethrotome and guide are withdrawn, and a large-sized Lister's metal sound is passed.

It may be necessary to reintroduce the urethrotome and repeat the notching, and the surgeon should not be content until a full-sized Lister's sound or a bougie of the size of No. 25 (French) can be readily passed. The hæmorrhage is, as a rule, very slight. Finally, a full-sized silver catheter is passed and the bladder emptied, and if thought advisable washed out with a warm antiseptic solution. Some inject an ounce or two of nitrate of silver solution (½ to 2 per cent.), and leave this in the bladder. During the whole operation the patient must be warmly wrapped up in blankets, and the same precaution observed afterwards. It is best not to leave a catheter in the urethra, and to allow the parts to rest for two or three days before again passing a Lister's sound of large calibre or a flexible bougie. Subsequently the regular introduction of the latter must be insisted on to prevent recurrence of the stricture.

Complications and Modifications of the Operation.—A troublesome accident that may easily happen is the breaking off of the bougie close to its attachment to the urethrotome. This is especially apt to occur if there has been a crack in the coating material of the bougie which has escaped notice.

In such a case the urethrotome should be withdrawn entirely (after division of the stricture), and a lithotrite or similar forceps introduced in order to seize and extract the bougie. Should these attempts fail, the patient should be placed in the lithotomy position, and a median section—into the membranous urethra —performed on a grooved sound. The finger can then be introduced into the bladder, and with its aid the exact position of the bougie detected and the instrument removed by straight dressing forceps.

Mr. Buckston Browne advocates the urethrotome of Civiale

and Sir Henry Thompson—*i.e.* one that cuts from the bladder side of the stricture forwards (Fig. 172). He makes the incision on the floor of the urethra, and states that it should be "one inch long and half an inch deep." No object can be gained by such a long incision for the majority of strictures, which are simply annular ; whilst half an inch is an extravagant depth which probably is rarely attained, and is certainly never required.

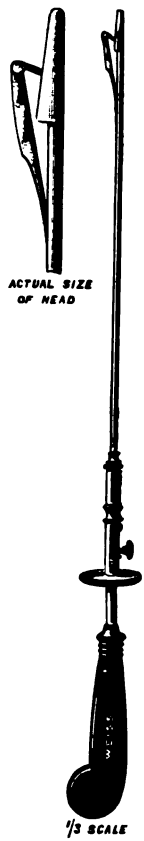


FIG. 172.—SIR HENRY THOMPSON'S URETHROTOME. (*Weiss.*)

The drawback to the urethrotomes which cut from the bladder side of the stricture is that they cannot be introduced until a No. 8 or 10 French bougie will pass. It is obvious that by the time a bougie of this size can be introduced the chief difficulty in a case of stricture has been already overcome, and often a cutting operation has become unnecessary. The instrument described and figured on page 640 (the Teevan-Maisonneuve) can be used on the tightest stricture provided a filiform bougie can be got through.

Besides the two forms of urethrotome mentioned above, there are a legion of others, one catalogue figuring no less than thirty-six varieties. Most of these seem to have been devised for the sake of mere originality. The Teevan-Maisonneuve urethrotome is one of the most ingenious and perfect of surgical instruments.

Double Strictures.—It is a rather prevalent delusion that urethral strictures are often multiple. This may arise from muscular spasm at the triangular ligament being mistaken for a stricture. It is a fact that true organic strictures are almost always single: analysis of a large series of internal urethrotomies by one of us (J. H.) showed that a double stricture was only present in 2 per cent.

Should **hæmorrhage** occur after internal urethrotomy an ice-bag should be applied to the perineum with elevation of the

pelvis, or a full-sized catheter (flexible if possible) may be passed and left in, whilst a firm pad of wool is fixed in the perineum by a T-bandage. The catheter should be kept clear, and the urine should run continuously through it and an attached rubber tube. An opiate should be given if there is pain or restlessness.

As already mentioned, hæmorrhage depends on too deep a single incision having been made in the roof of the urethra, and is to be avoided by making two smaller cuts, one on either side.

The Occurrence of Rigors.—The chief danger after urethrotomy is septic absorption into the veins of the urethral wall, leading to pyæmia or septicæmia. Fortunately, if due care is taken in the selection of cases for the operation, this is very rare. Sir Henry Thompson performed 340 internal urethrotomies with only six deaths. The occurrence of one or more rigors after the operation does not mean of necessity any serious complication, indeed it appears always to happen in a small proportion of the cases. In a series of fifty cases under one of us (in none of which was a catheter tied in after the operation) rigors were noted in four (*i.e.* 8 per cent.). Comparing this with fifty cases treated by a surgeon whose practice was to tie in a rubber catheter, rigors were met with in four patients also.

To avoid rigors after internal urethrotomy, the patient should be kept thoroughly warm in bed, should not try to pass urine for a few hours, and should freely drink warm water or weak tea. If a rigor should occur, it should be met by the immediate administration of ten grains of quinine in hot brandy and water.

Periurethral Abscess.—This is a not unfrequent complication in bad stricture cases; it occurred either before or after internal urethrotomy in seven out of fifty of the series alluded to above. The abscess requires prompt incision, but does not as a rule affect the satisfactory progress of the case.

EXTERNAL URETHROTOMY

The operations known by this name include several methods of opening the urethra by an incision in the perineum.

They are carried out in certain cases of stricture of the urethra which have resisted other methods of treatment, and which are, for one reason or another, unsuited to less severe surgical measures.

The following are the operations described :—

1. *Syme's Operation.*—In this operation a staff is passed through the obstruction, and upon it the stricture is divided.

2. *Wheelhouse's Operation.*—Here the urethra is opened upon the distal side of the stricture. The orifice of the narrowed canal is exposed, a director is passed into it, and guided by this instrument the surgeon divides the stricture.

3. *Cock's Operation,* or *Perineal Section.*—In this procedure the urethra is opened behind the stricture, and just in front of the prostate. No staff or artificial guide of any kind is used. The operation is applied to cases in which the urethra is practically impermeable. (*See* page 649.)

The term external urethrotomy is also employed in connection with the opening of the normal urethra through the perineum, for the purpose of draining the bladder.

This measure consists merely in opening the urethra immediately in front of the prostate by cutting upon a staff. After the incision is completed, the staff is withdrawn, and a perineal tube is passed into the bladder.

The general details of this simple operation are considered in the chapter on Median Lithotomy (page 583).

1. **Syme's Operation.**—*Instruments Required.*—Syme's staff. (This instrument has a narrow terminal part, which is passed through the stricture. Where this part joins the rest of the staff, there is a " shoulder," which rests against the distal surface of the stricture. The narrow segment is grooved, and the groove is continued on to the shoulder.) Manacles or Clover's crutch ; scalpel ; probe ; director ; Teale's probe gorget (Fig. 173) ; perineal tube ; catheter.

The Operation.—The patient is placed in lithotomy position, and the staff is introduced with the greatest care to prevent a false passage. An incision is made precisely in the median line of the perineum, and the knife is so directed that its point

shall hit the shoulder of the instrument. The surgeon must convince himself that this portion of the staff is laid bare. He then engages the point of the knife in the groove of the staff, and, keeping most carefully to the groove, thrusts the knife towards the neck of the bladder until he has divided the whole of the stricture. A director or probe, or Teale's probe gorget, is now introduced along the convexity of the staff into the bladder, and the staff is removed. A gum-elastic catheter may then be passed into the bladder through the penis, and be guided into position by the director or probe gorget, aided by the finger inserted into the wound.

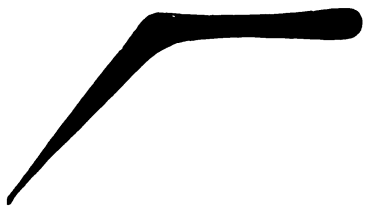


FIG. 173.—TEALE'S PROBE GORGET.

Should the irritability of the bladder prevent the retention of a catheter, a tube should be passed into the bladder from the perineum, and should be retained in position by tapes.

Whitehead's perineal tube, with sliding adjustable shield, is a useful instrument for the purpose.

As soon as possible, however, a catheter should be passed by the meatus, and the perineal wound allowed to close.

2. **Wheelhouse's Operation.**—*Instruments Required.*—Manacles or Clover's crutch; Wheelhouse's hooked staff (Fig. 174); two pairs of fine-nibbed forceps; scalpels; catheters; probe;

FIG. 174.—STAFF FOR WHEELHOUSE'S OPERATION.

probe-pointed director; Teale's probe gorget (Fig. 173); curved needles; needle-holder; Wells' forceps; sponges in holders.

The Operation.—The patient is placed in lithotomy position. "The staff is to be introduced with the groove looking towards the surface, and brought gently into contact with the stricture. It should not be pressed much against the stricture, for fear of tearing the tissues of the urethra and causing it to leave the

canal, which would mar the whole after-proceedings, depending as they do upon the urethra being opened a quarter of an inch in front of the stricture. Whilst an assistant holds the staff in this position, an incision is made into the perineum, extending from opposite the point of reflexion of the superficial perineal fascia to the outer edge of the sphincter ani. The tissues of the perineum are to be steadily divided until the urethra is reached. This is now to be opened in the groove of the staff, not upon its point, so as certainly to secure a quarter of an inch of healthy tube immediately in front of the stricture. As soon as the urethra is opened, and the groove in the staff fully exposed, the edges of the healthy urethra are to be seized on each side with straight-bladed nibbed forceps, and held apart. The staff is then to be gently withdrawn until the button-point appears in the wound. It is then to be turned round, so that the groove may look to the pubes, and the button may be hooked on to the upper angle of the opened urethra, which is then held stretched open at three points, and the operator looks into it immediately in front of the stricture. While thus held open, a probe-pointed director is inserted into the urethra, and the operator, if he cannot see the opening of the stricture—which is often possible—generally succeeds in very quickly finding it, and passes the point onwards through the stricture towards the bladder. The stricture is sometimes hidden amongst a crop of granulations or warty growths, in the midst of which the probe-point easily finds the true passage. The director having been passed into the bladder (its entrance into which is clearly demonstrated by the freedom of its movements), its groove is turned downwards, the whole length of the stricture is care-

FIG. 175.—WHEELHOUSE'S GROOVED DIRECTOR. (*Weiss.*)

fully and deliberately divided on its under-surface, and the passage is thus cleared. The director is still held in the same position, and a straight probe-pointed bistoury is run along the groove, to ensure complete division of all bands or other obstructions.

"These being thoroughly cleared, the old difficulty of directing the point of a catheter through the divided stricture and onwards into the bladder is to be overcome. To effect this, the point of a Teale's probe gorget (Fig. 173) is introduced into the groove in the director, and, guided by it, is passed onwards into the bladder, dilating the divided stricture and forming a metallic floor, along which the point of the catheter cannot fail to pass securely into the bladder. The entry of the gorget into the latter viscus is signalised by an immediate gush of urine along it. A silver catheter (No. 10 or 11) is now passed from the meatus down into the wound, is made to pass once or twice through the divided urethra, where it can be seen in the wound, to render certain the fact that no obstructing bands have been left undivided, and is then, guided by the probe-dilator, passed easily and certainly along the posterior part of the urethra into the bladder. The gorget is now withdrawn, the catheter fastened in the urethra, and allowed to remain for three or four days, an elastic tube conveying the urine away. After three or four days the catheter is removed, and is then passed daily, or every second or third day, according to circumstances, until the wound in the perineum is healed; and after the parts have become consolidated, it requires, of course, to be passed still from time to time, to prevent re-contraction" (Wheelhouse, *Brit. Med. Journ.*, June 24th, 1876).

The operation requires a good light and infinite patience. There is often some difficulty in detecting the orifice of the stricture, and matters may be complicated by a false passage.

The hooking of the button of the staff on to the upper angle of the opened urethra is not always of service. The instrument has to be held by an assistant, and is apt to be in the way. The

margins of the urethral wound may be conveniently held aside by long threads which have been passed by means of curved needles in holders.

3. **Cock's Operation.**—This operation consists in opening the urethra behind the obstruction, and at the apex of the prostate, unassisted by a guide. It is a modification of the old *boutonnière* operation, is sometimes spoken of as "perineal section," but is more correctly represented by the title "external urethrotomy without a guide."

Instruments Required.—Manacles or Clover's crutch; a broad double-edged knife with a very sharp point; a probe-pointed director in a handle (the handle and the shaft of the instrument should form such an angle as that in Teale's probe gorget); a perineal cannula; a gum-elastic catheter, to be retained in the bladder through the perineum.

The Operation.—The operation is thus described in the *Guy's Hospital Reports* for 1866:—

"The patient is to be placed in the usual position for lithotomy; and it is of the utmost importance that the body and pelvis should be straight, so that the median line may be accurately preserved. The left fore-finger of the operator is then introduced into the rectum; the bearings of the prostate are next examined and ascertained, and the tip of the finger is lodged at the apex of the gland. The knife is then plunged steadily and boldly into the median line of the perineum, and carried on in a direction towards the tip of the left forefinger, which lies in the rectum.

"At the same time, by an upward and downward movement, the vertical incision may be carried in the median line to any extent that is considered desirable. The lower extremity of the wound should come to within half an inch of the anus.

"The knife should never be withdrawn in its progress towards the apex of the prostate, but its onward course must be steadily maintained until its point can be felt in close proximity to the tip of the left fore-finger. When the operator has fully assured himself as to the relative position of his finger, the apex of the prostate, and the point of his knife, the latter is to be advanced with a motion somewhat obliquely, either to the right or the left, and it can hardly fail to pierce the urethra. If, in this step of the operation, the anterior

extremity of the prostate should be somewhat incised, it is a matter of no consequence.

"In this operation it is of the utmost importance that the knife be not removed from the wound, and that no deviation be made from its original direction until the object is accomplished. If the knife be prematurely removed, it will probably, when reinserted, make a fresh incision and complicate the desired result. It will be seen that the wound, when completed, represents a triangle; the base being the external vertical incision through the perineum, while the apex, and consequently the point of the knife, impinges on the prostate.

"The knife is now withdrawn, but the left fore-finger is still retained in the rectum. The probe-pointed director is carried through the wound, and, guided by the left fore-finger, enters the urethra and is passed into the bladder."

Along the groove of the director the cannula or perineal tube is passed into the bladder.

It only remains to secure this drainage tube in place by means of two tapes, which are attached to the sides of the tube on the one hand, and to the perineal strips of a T-bandage on the other.

Through the tube the bladder may be washed out. The stricture may now possibly be dealt with by such means as appear advisable. The operation is, however, usually carried out in cases in which the urethra is permanently obstructed or destroyed, in which urinary extravasation has taken place, and in which the perineum is infiltrated with inflammatory exudations, and probably riddled with sinuses.

The perineal opening is, therefore, as a rule, a permanent one; but should the urethra be once more restored to its normal calibre, the artificial opening in the perineum soon heals up.

There is no doubt that this operation may prove to be exceedingly difficult. It needs to be carried out with the utmost patience, care, and precision.

Repeated stabs in the dark may lead to severe bleeding; and if the urethra be not reached at the first or second attempt, the operation had better be abandoned.

We have allowed the description of Cock's operation to remain, but we believe that it can hardly ever be required. With care and patience every stricture, even if at first it seems

impermeable, can be overcome. Once a filiform bougie is introduced internal urethrotomy will obviate the adoption of a method which is almost certain to leave a perineal fistula. For the same reason we consider that Wheelhouse's operation should also be very rarely resorted to.

Excision of the Strictured Portion of Urethra.—In a small number of cases this has been carried out with success. It is best suited to annular strictures which resist the ordinary measures of treatment. A traumatic stricture in a young adult may be taken as an example. A careful dissection from the perineum is made, the narrowed portion exposed, and the urethra divided transversely in front of and behind the stricture. After the intervening part has been cut away with scissors, the two ends are brought together by fine catgut sutures inserted first into the dorsal surface of the wall. The suturing is completed over a catheter, which should be left in for a few days. Extra sutures of silkworm gut through the overlying tissues and skin should be inserted to relieve the tension on the deep ones. The proceeding is of very limited application, and may be attended with much difficulty. Unless perfect suturing and union be obtained, the stricture may be in no way improved. Successful cases have been recorded by Mr. Pearce Gould, Mr. T. H. Openshaw, and others; but the method is not likely to come into regular use, and can only be required in very exceptional cases.

CHAPTER XXIV

OPERATIVE TREATMENT OF ENLARGED PROSTATE

So long as a patient with enlarged prostate can live in comfort with the occasional use of a soft catheter, no operation is to be advised. But when catheterism becomes increasingly frequent and difficult the question of a radical operation has to be considered. Recent experience has shown that the risk of prostatectomy is much less than it was formerly considered to be; and, further, that the complete removal of the large adenomata which usually form the obstruction is attended by results with which those following partial excision cannot be compared.

Before describing the operation of prostatectomy, we have to note a number of alternative measures which have had a certain vogue of late years.

1. The division of a supposed prostatic bar by the galvano-cautery introduced through the urethra (Bottini's operation), though still advocated abroad by some surgeons, must be wholly condemned. It is a blind and dangerous method, from which no permanent relief can be expected. The same may be said of "tunnelling the prostate."
2. Ligature of the internal iliac vessels in order to induce atrophy of the gland has been tried repeatedly with no success.
3. Excision of one or both testes, or the more trivial operation of "vasectomy" (ligature and division of both vasa deferentia), performed with the same idea of inducing atrophy, has a literature out of all proportion to the benefit derived from such methods.

It may, indeed, be said that both operations are now abandoned, or ought to be.

4. Permanent drainage of the bladder above the pubes (or by the less suitable perineal route) is only a palliative measure. It substitutes one grave inconvenience for another, and it can be so rarely indicated that no description of the measure is here required. In cases complicated by severe cystitis or hæmorrhage, temporary drainage and washing out the bladder may be indicated as a preliminary step to prostatectomy.

The patient with prostatic obstruction has therefore the two alternatives before him of regular catheterism or of prostatectomy.

In presenting these alternatives it must be remembered that the risk of the operation is much increased by the presence of cystitis or of renal complications, and that it is wrong to advise the use of a catheter unless the patient can be trusted to take constant precautions to ensure asepsis. In any case of prostatic enlargement, if residual urine is found to exist, or if the urethra is intolerant of the passage of a catheter, operation should be advised—in the absence of contra-indications. A thorough examination of the urine is indispensable in every case, and occasionally the cystoscope may be employed with advantage. As a rule, however, the latter instrument is unnecessary and somewhat dangerous.

History of the Operation.—The late Mr. McGill, of Leeds, was the pioneer of suprapubic prostatectomy. He advocated strongly that the bladder should be opened above the os pubis in preference to approaching it from the perineum. How closely the modern operation follows the lines laid down by McGill will be seen by the following quotation (given in the first edition of this work) from the *Lancet*, February 4th, 1888 :—

" The prostate should be removed as far as possible by enucleation with the finger, and not by cutting. The mucous membrane over the projecting portion having been snipped through, the rest

of the operation is completed with finger and forceps. In this way excessive hæmorrhage is prevented. Hæmorrhage is best arrested by irrigation with water so hot as to make it unpleasant for the hand."

It is well to emphasise the fact that to McGill is due the sole credit of originating the operation, and that many surgeons following his teaching have since performed complete removal of the hypertrophied part of the prostate with success. As Mr. Mayo Robson writes (*Brit. Med. Journ.*, September, 1902) :—

" Prostatectomy for the relief of urinary obstruction is an operation that was unknown before 1886 ; it owes its origin to our late and much-lamented colleague, McGill, whose name and reputation as a surgical genius add lustre to the Leeds School, and, in fact, to British surgery. He not only originated the operation, but improved and perfected it, and those members of the profession who attended the meeting of the British Medical Association in Leeds in 1889, will remember with what natural pride he showed a number of aged patients in good health on whom the operation had been done."

It must, however, be noted that of the twenty-four cases then reported by McGill, Atkinson and others, the operation had proved fatal in four (nearly 20 per cent.), and that only seven of the twenty remaining were able to dispense entirely with the use of a catheter. To Mr. P. J. Freyer we owe the advocacy and general adoption of enucleation of the entire prostate in preference to the use of cutting instruments, or of partial prostatectomy. Mr. Freyer's description and narration of his cases are given in detail in a long series of papers published in the *Brit. Med. Journ.* of 1901, 1902, etc.

Many surgeons took part in the controversy which followed these papers, two main questions being debated—first, whether it was possible to enucleate the entire prostate " in its capsule " ; secondly, whether Mr. Freyer's was a new form of operation. The whole subject is ably discussed and summarised in two interesting papers by Mr. Southam and Sir William Thomson (*Brit. Med. Journ.*, April 18th, 1903).

Anatomical and other Considerations.—As seen in Fig. 176, the prostate is composed of two lateral lobes, separated only in part by the urethral canal. The so-called middle lobe would appear to be in most, if not all, cases a projection upwards behind the vesical orifice from one or other lateral lobe ;

it is always a pathological product. The apex of the prostate rests on the triangular ligament; the base or upper end is closely connected with the sphincter of the bladder.

The prostate is encased in a fibrous capsule which sends in processes amongst the glandular masses of which the organ is largely composed. These septa of fibrous tissue are reinforced by much unstriped muscular tissue and by blood-vessels. How much of the normal prostate is glandular will be seen from Fig. 177.

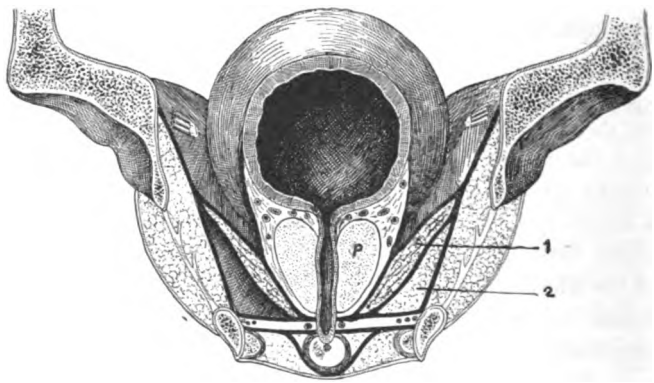


FIG. 176.—SECTION THROUGH THE PROSTATIC URETHRA TO SHOW THE RELATIONS OF THE PROSTATE GLAND (P) TO ITS FASCIAL INVESTMENT, ETC. (*After Testut.*)

1, Levator ani, enclosed between two layers of fascia, the inner one forming the true sheath of the prostate; 2, Ischio-rectal fossa. The capsule which closely adheres to the prostate is shown as a thin line, outside which are many veins cut across.

Immediately outside this fibrous sheath of the prostate is a plexus of veins and then the recto-vesical sheath of fascia, which forms an outer investment of the prostate and separates it from the levator ani, the rectum, and the os pubis. It is important to note that when removal of the entire prostate in its capsule is spoken of, the inner true capsule is meant, and not the recto-vesical layer, which is prolonged upwards (encasing the vesiculæ seminales) on to the rectum and bladder. The venous plexus alluded to is particularly well developed in front of the prostate (Fig. 177), between it and the os pubis, as well as around the neck of the bladder. It is mainly from this plexus that the hæmorrhage occurs during and after prostatectomy.

It may be said that all *large* prostates are formed of adenomata, which are peculiarly suited to enucleation, as the adenomata separately or the entire gland converted into a mass of them can be readily shelled out with the fingers.

In so-called complete prostatectomy the removed parts consist of (1) large adenomatous masses which fuse behind, but in front are united by a thin isthmus, chiefly of connective tissue, (2) the greater part or the whole of the prostatic urethra, (3) a capsule of connective tissue with a variable amount of circular muscle-bands. A thin layer of prostatic gland tissue is usually left behind with the fascial sheath of the prostate derived from the recto-vesical layer. It is this intact fascial capsule which prevents extravasation of urine after prostatectomy.

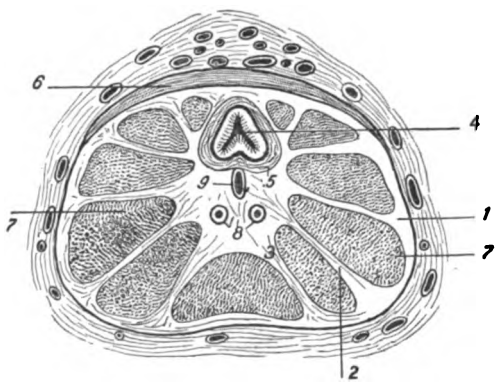


FIG. 177.—SECTION THROUGH THE PROSTATE GLAND. (*After Testut.*)

1, Fibrous tissue and unstriped muscle forming a capsule and sending in (2) septa between (7) the lobules of glandular structure; 6, Transverse muscle band belonging to the vesical sphincter; 8, Common ejaculatory ducts; 3, Central area of connective tissue; 4, Prostatic urethra (mucous coat); 5, Circular muscle of urethra; 9, Sinus, or utricle.

As the prostate enlarges, its projection is mainly upwards into the bladder, hence the extent to which it bulges towards the rectum is a very imperfect index to the total enlargement. Hence, also, enucleation from above the pubis is naturally easier than from the perineum. In many cases directly the anterior wall of the bladder is incised the projecting mass comes into view.

The severity of the patient's symptoms or the degree of obstruction is not closely related to the size of the enlarged prostate. In some cases—fortunately the minority—the enlargement is mainly due to increase of fibrous and muscular tissue. Thus a dense and comparatively fixed prostate of no

great size is produced. Enucleation under such conditions is more difficult and dangerous than when the gland is the seat of common adenomatous hypertrophy. Should the surgeon after opening the bladder find that the prostate is very tough, and that attempts to enucleate it are attended with serious bleeding, he will do wisely to content himself with a partial prostatectomy, removing the direct obstruction at the neck of the bladder by means of cutting forceps.

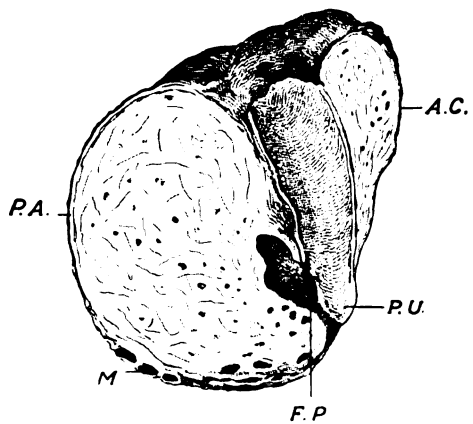


FIG. 178.—VERTICAL SECTION OF AN ENLARGED PROSTATE REMOVED BY THE SUPRAPUBIC OPERATION.

P.U, Prostatic urethra; F.P, a small false passage due to catheterisation; A.C, Anterior part of capsule; P.A, Posterior part of capsule containing (M) bands of unstriped muscle fibre.

The relation of the prostatic urethra to the enlarged organ is of importance. The urethra traverses the front part of the gland, and by careful enucleation on either side as well as from behind, it is often possible to leave the canal intact. In many cases, however (Fig. 178), this portion of the urethra has been removed with the rest of the gland. The mucous membrane of the bladder will then ultimately become continuous with the membranous urethra at the triangular ligament. It is a surprising fact that no harm results from this removal of a considerable part of the urethra.

The two common ejaculatory ducts pass obliquely through the prostate, lying side by side, and in enucleation of the gland they must of necessity be torn across. (Figs. 177 and 179.)

It is not unfrequent for calculi in the bladder to complicate prostatic enlargement, and the suprapubic incision enables them to be readily removed before enucleating the gland. In

one case Mr. P. J. Freyer extracted ninety-six calculi. The operator should aim at removing the obstructing mass down to the triangular ligament, though whether the entire gland is got away in all cases may be doubtful. It is certain that a thin layer of prostate, spread out around the main adenomatous tumour, is frequently left behind.

The age of the patient is no bar to operation. In most of the cases operated on the age has been from sixty to seventy years. In one case I (J. H.) removed the prostate from a patient eighty years old, and he regained normal control over the bladder.

Preparation.—It is, of course, desirable to diminish the shock by rapid operating and by guarding the patient against chill in every possible way. Theoretically the urine should be made aseptic beforehand, but this may be impossible in the presence of residual and decomposing urine which cannot be washed out.

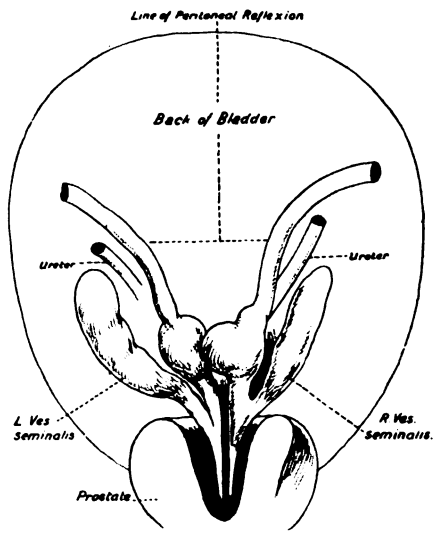


FIG. 179.—SKETCH SHOWING RELATION OF STRUCTURES IMMEDIATELY BEHIND THE BLADDER.
The prostate gland is incised to show the course of the common ejaculatory ducts.

Although Mr. Freyer and others have recorded some brilliant results in patients who were reduced to a very low condition by cystitis and other complications due to septic urine, it is at least open to question whether the operation should not be divided into two stages under these conditions. The bladder might be drained suprapubically and washed out daily through the rubber tube, internal remedies (urotropine or helmitol gr. 10 to 15, boric acid gr. 20 as a dose given with acid phosphate of

soda 30 to 60 grains) being simultaneously employed. We would urge that in every case if possible preliminary treatment for a few days in bed should be employed, and that if the urine is septic a careful attempt should be made to improve its condition. If a catheter can be passed and the bladder washed out, so much the better. Warm boric solution or a very weak one of nitrate of silver (five grains to the pint) are very useful. If no catheter can be passed and suprapubic drainage seems indicated, it can be easily performed under local anæsthesia or the use of nitrous oxide gas.

The importance of examining as to the existence of chronic nephritis cannot be overrated, as advanced kidney disease is certain to be fatal to the success of the operation.

The Anæsthetic.—The operation is not a long one and has been often performed under nitrous gas, but A.C.E. or chloroform is preferable. Spinal anæsthesia with stovaine or tropococaine has been especially recommended because of the absence of venous congestion which a general anæsthetic may produce. Further experience must decide as to their relative advantages.

Suprapubic Prostatectomy.—A catheter should be introduced, the urine drawn off, and the bladder lightly distended with warm boric solution. The hand placed on the hypogastrium will show when the distension is sufficient.

The pelvis should be somewhat raised. The incision—three inches long—should be made immediately above the pubes in the middle line. The recti being separated, the transversalis fascia is divided and the prevesical space opened up. The bladder wall is then clearly made out, and either a sharp hook or a silk suture inserted towards its upper end. The suture gives the better hold. A sharp-pointed scalpel is then thrust through the anterior vesical wall. The opening should not be made close to the pubes, as there the upward projecting prostate might be in the way. A couple of sutures should be inserted into each side of the bladder wound, so that it may be held

forwards, and the escaping urine or fluid should be rapidly mopped up with sponges. The bladder is now explored with the fingers, and if calculi are found behind the prostate they should be at once removed. In most cases the enlargement will be found to be adenomatous with one or more intravesical projections. Guided by the left index finger, an incision is made with knife or scissors through the mucous membrane covering either lateral projection. This can be easily enlarged with the finger, which indeed may be used to scrape through the mucous membrane itself, no cutting instrument being in such case employed.

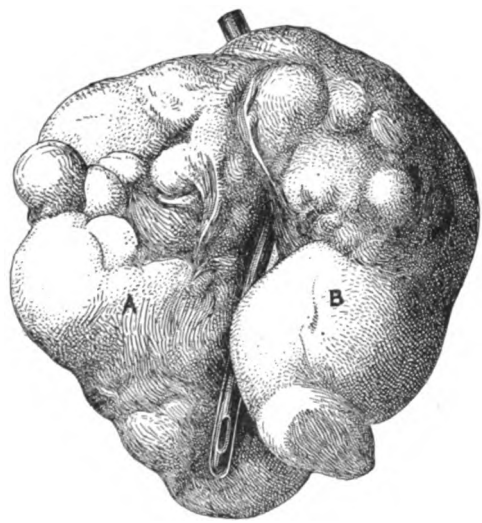


FIG. 180.—PROSTATE WEIGHING 6½ OZ. REMOVED FROM PATIENT AGED 68.

A B, Lateral lobes; bladder end of B shows an ulcer caused by calculi, the catheter placed in course of the urethra showing its tortuous shape. (*From one of Mr. P. J. Freyer's cases.*)

The position and method of the division of the mucous membrane are most important. Long-handled, short-bladed scissors curved on the flat are the most suitable, and are preferred by most operators to the finger nail. The apex of the intravesical projection should be the point aimed at, some little distance from the bladder wall. From this point the operator works to either side around to the front. If no median projection of the prostate exists the mucous membrane should be divided at the sides (corresponding to the letters A and B in Fig. 180).

The growth is then enucleated, working downwards and inwards towards the triangular ligament on either side. Much assistance may be obtained by the surgeon's left-hand fingers (or

those of an assistant) in the rectum.* It is usually best to remove the enlarged prostate in one piece (*see* Fig. 180), and it is therefore useless to attempt to preserve that portion of the urethra which lies in the organ. The hæmorrhage may be considerable, but no attempt at stopping it can be made until the growth has been removed from the bladder. In some of Mr. Freyer's cases the actual enucleation of the gland has occupied only five minutes, or less. A sponge wrung out of hot water should then be introduced and pressed down on the bleeding area. It is possible that tincture of hamamelis or adrenalin solution would be useful to check the oozing, but the heat and pressure of the sponge generally answer well enough.

No attempt is usually made to sew up the bladder wound, the two stitches inserted in each edge being secured to the skin. A large soft rubber tube is then inserted and fixed by a stitch ; a large absorbent dressing is now applied over the pubes, and retained by a many-tailed bandage. The whole of the urine escapes through the wound for two or three weeks, and very frequent change of dressings and constant attention to cleanliness are required on the part of the nurse.†

The bladder should be gently washed out every day with a warm aseptic solution. This may be done through a rubber catheter introduced by the urethra, or by the suprapubic drain being made double (the " two-way tube "). It is not a good plan to leave a rubber catheter *in situ*, as its presence is apt to set up urethritis and epididymitis.

The tube and stitches may be removed about the fourth day. From two to three weeks after the operation the urine begins to pass through the urethra, and this should be favoured by

* Mr. Lynn Thomas has invented a kind of metal spoon, one end of which is introduced into the rectum and made to elevate the prostate by depression of the other end, or handle, of the instrument between the patient's thighs. We do not see any advantage to be gained from this metal elevator, as the fingers are sensitive and therefore better adapted for the purpose.

† The use of the apparatus described and figured on page 581 will help materially in keeping the patient dry and clean. It is, however, somewhat irksome to wear.

keeping the patient in the sitting posture and getting him out of bed as soon as possible.

After prostatectomy a pouch is left of varying dimensions which is not lined with normal mucous membrane, and which has slowly to contract. Phosphatic deposit readily occurs in this pouch, and hence care should be taken to keep the urine slightly acid. Now and then a calculus forms during convales-

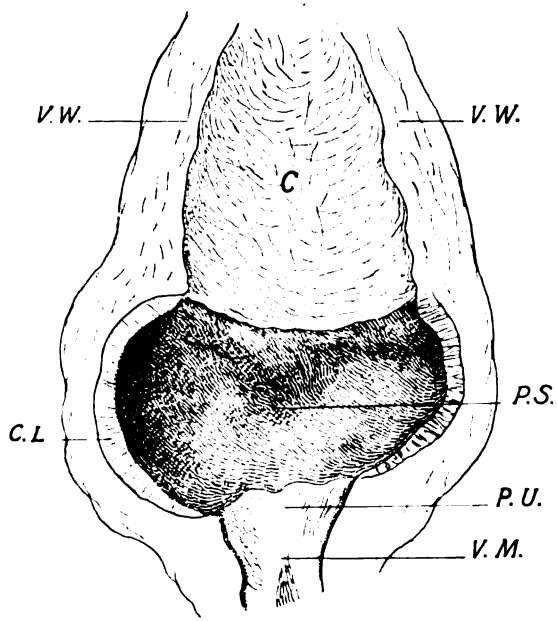


FIG. 181.—THE BLADDER, OPENED FROM THE FRONT, FROM A CASE OF SUPRAPUBIC PROSTATECTOMY. THE PATIENT DIED A FEW DAYS AFTER OPERATION.

P.S., Large space or cavity left by removal of the prostate; C.L., Thin capsule of tissue, chiefly glandular; P.U., Part of prostatic urethra left; V.M., Verumontanum; C., Contracted upper part of bladder; V.W., Muscular vesical wall.

cence, in that case lithotrity may become necessary. Another troublesome complication is obstruction of the vesical orifice by a valvular flap of mucous membrane. Finally "there is no doubt that contraction may lead to a true stricture, and at present it is impossible to say how often this occurs." (A. Edmunds, *Practitioner*, January, 1908.)

If the entire obstruction has been removed, the bladder will regain control in from a month to six weeks after the operation. The condition of "vesical atony" which was supposed to be present in many cases of prostatic enlargement appears to have no real existence (Freyer).

Variations in the After-treatment.—The urine soaking the dressings and irritating the edges of the wound is a disadvantage which is sometimes overcome in the following way. A long rubber tube is fixed by carefully suturing the bladder wound with a continuous catgut stitch, so as to occlude the latter, except just at the exit of the tube, the other end of which is carried into a bottle at the side of the bed. All round the tube gauze is packed and secured with bandage. For several days the patient may be kept clean thus, but unless the urine drains well through the tube the latter will have to be taken out. See also the note on p. 660.

Comments on the Operation.—The smaller the tumour the greater is the difficulty of its removal. This is owing to the fact that the large prostates are almost entirely adenomatous growths, which shell out with surprising facility. On the other hand, a firm, hard prostatic ring at the neck of the bladder will prove to be largely fibrous, and if this condition is found on opening the bladder the surgeon, as we have said, should limit his operation to cutting away the actual projection.

Prostatic obstruction is occasionally due to carcinoma of the gland, and although it may be possible to shell out such a gland (Mr. Reginald Harrison and others have recorded examples), the relief given can only be temporary, and is obtained at serious risk.

When the obstruction is found to be due chiefly to a very vascular and loose mucous membrane with but slight enlargement of the prostate, Mr. Bruce Clarke recommends cauterisation with Paquelin's or the galvano-cautery through the suprapubic wound.

Sir William Thomson (*Brit. Med. Journ.*, Jan. 27th, 1906) has shown that suprapubic prostatectomy may be done with success

even when severe hæmorrhage is present. In the case he reports there were many calculi in the bladder as well as an adenomatous prostate.

In certain cases, after enucleating the prostate, the surgeon has drained the bladder through the perineum as well as above the pubes, but this should be avoided as a rule.

Perineal Prostatectomy.—In America removal of the prostate through the perineum has been especially advocated, but seeing that the growth usually projects upwards into the bladder far more than towards the perineum, the advantage of this route is doubtful. One drawback is the great depth of the wound.

The Operation.—The patient being in the lithotomy position, a curved metal staff or sound is introduced if possible into the bladder; if not, as far as it will go. On this one assistant draws forward the bulb of the urethra. An incision, either transverse or curving forward at either end, is made across the perineum. The wound gapes widely, it is steadily deepened between the rectal wall and the prostate, special care being taken not to damage the former. Should the rectum be slightly torn the rent should be closed by suture.

The rectum is guarded and drawn backwards by a broad curved retractor. The fibres of the levator ani lying between the prostate and rectum require to be divided. There will be a certain amount of hæmorrhage from veins connecting the prostatic and hæmorrhoidal plexus. When the prostatic sheath is exposed it should be divided in the middle line, and the gland separated from it as far forward as possible on either side with an elevator or the finger. The prostatic urethra is now opened, and the subsequent enucleation of each lateral lobe assisted by the surgeon's finger in the urethra (the staff having been removed). If the prostate reaches high into the bladder, pressure made above the pubes will be of material assistance. Several instruments have been devised for making downward traction on the prostate. Young's depressor is one of the best. It is opened out after introduction through the wound in the urethra.

Especial care must be taken in peeling off the vesical mucous membrane and the wall of the prostatic urethra from the prostate. Scissors should be sparingly employed, but are generally required in detaching the front part of the prostate. The bladder should be explored with the finger, and if calculi are found they can be removed by forceps or scoop.

The hæmorrhage as a rule is easily controlled by temporary plugging. Two courses are then open to the surgeon. One consists in drainage by a soft rubber perineal tube; the other in passing and leaving a rubber catheter through the whole length of the urethra, and sewing up the wound in the latter over the catheter by catgut sutures. In either case urine will leak through the perineum for a few weeks.

Comparison between Suprapubic and Perineal Prostatectomy.—As regards the mortality there appears to be little difference. Freyer reports 312 cases of suprapubic operation with twenty-two deaths (7 per cent.). From the writings of Young, Watson, and other American surgeons, the perineal operation appears to be followed by a mortality of about 6 per cent. The suprapubic operation is somewhat easier to perform, but sexual power is more apt to be lost than after the perineal operation.

On the other hand, certain complications are especially apt to occur with the latter, namely, incontinence of urine (in 3.5 per cent. according to Watson), injury to the rectal wall, and epididymitis.

The suprapubic method is the one usually adopted by English surgeons, and our knowledge of the perineal operation is at present chiefly obtained from American writers. Time alone can show which is the better and safer. Certainly the perineal method has the advantage of being performed under the direct vision of the surgeon.

CHAPTER XXV

OPERATIVE TREATMENT OF VARICOCELE

Anatomy of the Cord.—The vas deferens lies at the posterior aspect of the cord, and is to be easily recognised by its whipcord-like density when rolled between the thumb and finger. A considerable amount of connective tissue surrounds the vas and the blood-vessels of the cord. Three arteries occupy the cord: the spermatic, from the aorta, lies in front of the vas; the deferential artery, from the superior or inferior vesical, lies by the side of the vas; the cremasteric artery, from the deep epigastric, lies among the superficial layers of the cord and in its outer segment (Fig. 183).

Of the three arteries only the spermatic and the deferential supply the testicle, and chiefly the former. But as shown by the results of operation for varicocele (in which the spermatic artery is almost invariably tied), the deferential artery is capable of sufficient enlargement to carry on the blood supply of the testis.

One of us (J. H.) investigated the veins of the cord in a series of dissections and microscopic sections. The examination was made on thirty subjects, and the results given (Fig. 182) agree closely with those deduced by Mr. W. G. Spencer from a similar research.

The veins are divided roughly into two sets. The anterior and by far the larger set runs with the spermatic artery, is bound together by a good deal of connective tissue, and forms the pampiniform plexus. The posterior set is small, and surrounds the vas deferens, running with the deferential artery.

The spermatic artery in the great majority of cases runs in the middle of the anterior bundle of veins, from which it is practically impossible to isolate it. Both anterior and posterior sets lie within all the coverings of the cord. A few isolated veins, independent of these sets, are found among the tissues of the cord.

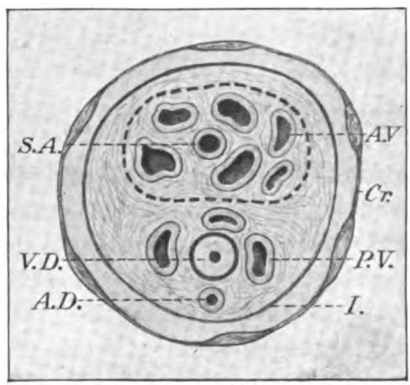


FIG. 182.—TRANSVERSE SECTION OF THE SPERMATIC CORD.

A.V., Anterior bundle of veins, the dotted line round which indicates the ligature in the operation for varicocele; S.A., Spermatic artery closely surrounded by the veins; V.D., Vas deferens; P.V., Posterior set of veins; A.D., Artery to the vas deferens; I., Sheath of cord derived from the infundibuliform fascia; Cr., Cremasteric sheath and muscle.

It would appear from Mr. Spencer's inquiries that the veins in the left cord are always larger than those of the right; and in connection with this point it may be observed that the congenital origin of varicocele is very generally allowed.

In severe cases of varicocele all the veins of the cord would appear to be involved. In ordinary cases the veins only of the pampiniform plexus are sufficiently dilated to require treatment.

In the operation for varicocele it is important to deal only with the anterior bundle of veins, and to spare those around and behind the vas deferens.

It must be remembered that the testicle is a vascular gland, and that it is possible so far to occlude the veins returning from the organ as to lead to serious disturbance (p. 670).

In some cases of varicocele there is present, besides the dilated veins, a condition of extreme laxity of the scrotal skin, the dartos, and the other coverings of the testis. From this cause the organ hangs very low, sometimes as much as eight inches from the external ring, and mere excision of part of the veins will not restore it to the normal level. In a case of this kind it is best to excise a considerable piece of scrotal skin and

dartos at the same time that the pampiniform plexus is dealt with; but in the great majority of cases resection of the veins will suffice. Before the introduction of antiseptic and aseptic measures various methods of subcutaneous ligature or division were employed, but the only satisfactory and safe operation consists in exposing the anterior bundle of veins by a short incision through the coverings of the cord, isolating these veins from the vas deferens, etc., applying a double ligature, excising the bundle for a distance of one or two inches, and securing the two severed ends together.

Some difference of practice exists as to the exact position of the skin incision. The veins are largest near the testis, but wounds made through the scrotum are more difficult to keep aseptic than those made towards the inguinal canal. For this reason, as in herniotomy, the tendency of late years is to place the incision higher up than formerly. If the relaxed scrotum requires to be dealt with, it is best to make the two wounds quite independent.

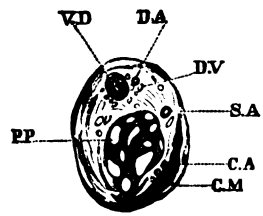


FIG. 183.—SECTION OF THE LEFT SPERMATIC CORD OF AN ADULT, AT THE LEVEL OF THE EXTERNAL ABDOMINAL RING, VIEWED FROM ABOVE. (*From a specimen prepared by Mr. W. G. Spencer.*)

V.D., Vas deferens; D.A, Deferential artery; D.V, Deferential veins; S.A, Spermatic artery; C.A, Cremasteric artery; C.M, Cremaster muscle; P.P, Pampiniform plexus.

Preparation of the Patient.—The pubic area should be carefully shaved (on both sides) the day before the operation, the skin thoroughly cleansed, and an antiseptic compress applied. The delicate nature of the scrotal integument should be borne in mind, and strong antiseptic solutions avoided both before and during the operation. The bowels should have been well opened.

Steps of the Operation.—The operator stands on the left side, one assistant raises and steadies the cord by holding the testis with his fingers from below, whilst another sponges. An incision is made, one and a half inches long, parallel to and directly over the cord, immediately below the external ring. The cut divides skin, connective and fatty tissue, the inter-

columnar fascia, and the cremasteric layer. The latter is easily recognised by its longitudinal muscle bands. The edges of this fascia are then held aside by Wells' forceps, and the anterior bundles of veins come into view covered by the thin infundibuliform fascia. The latter is carefully divided and peeled off with forceps, so that an aneurysm needle can be introduced under the veins, but in front of the vas deferens. The veins must be perfectly bared, and cleanly exposed. It must be ascertained for certain that the vas and the vessels which lie behind it are not included. A catgut ligature of medium thickness is then drawn under the anterior bundle, which is cleared of surrounding tissues for a distance of about two inches. If it is desired that the lower part of the veins should be ligatured rather than the upper, they can be easily reached by making traction on the cord. A second ligature is introduced, and the veins are then ligatured in two places, about one inch and a half apart. The lower ligature should be tied first. The vessels so isolated are divided with scissors close to the ligatures and removed.

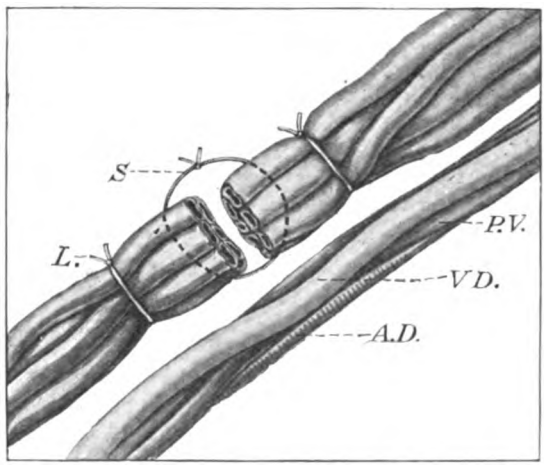


FIG. 184.—OPERATION FOR VARICOCELE. THE CORD IS VIEWED FROM THE SIDE.

L., One of the two catgut ligatures applied round the anterior set of spermatic veins (and artery); S., Fine catgut suture bringing the two ends together after excision of an inch or more of the veins; V.D., Vas deferens; A.D., Artery to vas deferens; P.V., Posterior set of spermatic veins.

The amount excised will be represented by about one inch, the scissors being applied about a quarter of an inch from the ligature.

There is no need to clamp the veins above the site of the proposed excision in order to render them distinct.

Almost invariably the spermatic artery will be included in the ligatures, as it lies surrounded by the veins of the anterior bundle.

Occasionally the artery can be identified and held aside, but this is rarely possible, nor does it appear to be at all important. After the intervening portion has been excised, the two cut ends are secured together by fine catgut sutures introduced on a curved needle, traversing the occluded veins beyond the two encircling ligatures (Fig. 184).

If two pairs of dissecting forceps are gently used in clearing the varicocele from the surrounding tissues, there is little risk of damaging the vessels. The action of the forceps must be supplemented by the scalpel. There must be no tearing of the fascia asunder with the fingers.

The superficial external pubic vessels are often in the line of incision, and if they have been divided should be secured with catgut ligatures.

A blunt hook having been inserted at each extremity of the wound, in order to bring the edges of the incision parallel, the sutures are introduced. Fine red silkworm gut should be employed. Colourless gut sutures are apt to be overlooked. Fine catgut also makes an excellent suture material. The wound is dressed with sterilised gauze and wool, and a spica bandage applied as for hernia. It is well to support the testes on a small pillow by some simple form of suspender.

If the wound has been made lower down through the scrotum, it must be protected by a dressing enveloping both testes. This is somewhat difficult to keep in place, and is uncomfortable in hot weather. Celloidin or collodion dressings cannot be used to the scrotal skin, as they irritate it too much. The wound is a very small one, and if made over the cord just as it emerges from the external ring, a light dressing can be easily retained by means of the spica bandage.

The first dressing need not be changed until the fourth day, and the sutures may be removed on the seventh.

Healing by first intention is the rule after this operation. The patient should be kept in bed for from seven to fourteen days. At the end of three weeks he will probably be able to resume his work. He may wear a suspender for a time, but this is by no means necessary.

Modifications.—Some surgeons use silk for ligaturing the veins. The objections to this are the same as in the case of radical cure of hernia. In a large number of operations we have been thoroughly satisfied with catgut (not chromicised) for the purpose.

Excision of Part of the Scrotum.—This proceeding should be reserved for the exceptional cases of extreme laxity of the skin and muscles supporting the testicle. The pendulous scrotum is drawn through a pair of narrow bladed curved forceps, such as are used in circumcision, until the testis is seen to be well braced up. The forceps (their convexity being downwards) are then held firmly whilst the redundant tissues are excised with a sharp-pointed bistoury. On the grip of the forceps being relaxed there will be free oozing from the scrotal veins and arterial twigs. This should be thoroughly stopped by pressure forceps, and if necessary by ligature, before the wound is sewn up. All sutures in the scrotum must be introduced close to the edges of the wound; otherwise the dartos tucks in the skin and prevents rapid healing.

Excision of the redundant scrotum is usually combined with operation on the veins of the cord, as already described.

Results of Open Ligature and Resection in Varicocele.—So far as our experience goes, the result of the operation is certain; and the procedure may claim to effect a radical cure. The wound heals well, and the after-treatment is not painful. There may be some œdema of the scrotum, and a little engorgement of the testis; but among a now considerable number of cases we have never met with an example of orchitis.

It is important that the pampiniform plexus or anterior bundle only should be dealt with. Mr. Jacobson (Holmes's "System of Surgery," vol. iii., p. 571) mentions a case where

some gangrene of the testis followed the excision, due, he believes, to the inclusion of too many veins in the ligatures. The veins which accompany the vas deferens should be left untouched.

There is not the least doubt that the main trunk of the spermatic artery is often included with the veins, and is divided. No harm follows this division. The testicle does not slough, as some have surmised, nor does it become violently inflamed or undergo atrophy. The artery to the vas deferens certainly escapes injury, and appears to bring enough blood to the testicle by means of its anastomosing branches with the spermatic to maintain the healthy life of the testicle.

Messrs. Corner and Nitch (*Brit. Med. Journ.*, Jan. 27th, 1906) report the results in 100 cases of high operation for varicocele performed at St. Thomas's Hospital.

The chief complications observed were hydrocele 23 per cent., thickening of the scrotum 50 per cent., and suppuration 4 per cent. They speak also of several cases of hæmorrhage due to slipping of a ligature (including two in which "the pelvis was filled with blood"), and on this account deprecate the plan recommended of securing the two ends of the divided veins together. With this conclusion we entirely disagree—the method described is the surest one to avoid oozing, as it leaves no gap. Messrs. Corner and Nitch admit that the high percentage of complications noted had "doubtless arisen from the operation being intrusted almost invariably to the less experienced," an admission which has at least the merit of candour.

CHAPTER XXVI

OPERATIVE TREATMENT OF HYDROCELE

THE chief palliative measure consists of repeated simple tappings. The curative measures have for their object the obliteration of the hydrocele sac.

Under this head will be considered the treatment by injection, and by excision of the parietal part of the sac.

Of these two methods undoubtedly the best is open excision. Injection is uncertain in its results, and often attended with much pain. We have only retained a description of it because it is still performed by many surgeons, and because some patients refuse to submit to a cutting operation, or one involving an anæsthetic, for their hydrocele. That injection is performed without an anæsthetic is its sole advantage.

In the present sections it is considered that the hydrocele of adults is referred to. In the treatment of the hydrocele of infants and young subjects certain especial points are involved which need not be dealt with here.

Simple Tapping.—The position of the testicle must be made out by means of the patient's sensation, the use of transmitted light, and by following the vas deferens into the scrotum. In inversion of the testis—a condition where the epididymis lies to the front—the gland may be applied to the anterior wall of the sac, and be immediately pierced in tapping at the usual site.

The patient should stand with his back against a wall; or, if he be old or nervous, may lie on his side at the edge of a bed. We have seen this little operation attended by alarming faintness.

The scrotal tissues are grasped from behind with the left

hand, and the skin over the front of the swelling is thus made as tense as possible. The skin should be carefully cleansed all round the site of puncture with 1 in 20 alcoholic solution of carbolic acid or some other appropriate antiseptic. The trocar and cannula must be sterilised in boiling water before being employed. It is important that the cannula should fit close. The end of the right fore-finger is placed on the trocar one inch from the point, to prevent too deep a plunge. The instrument is stabbed sharply into the sac at about the junction of its middle and lower thirds. The site of any visible vein is avoided. The instrument is first directed backwards, and then, when it is well into the sac, is sharply turned upwards to avoid the testicle. All the fluid should be removed, and then a little tuft of sterilised wool should be applied with collodion over the puncture.

The patient should wear a suspender. He should, if possible, rest in the recumbent posture for the remainder of the day of the operation.

A fresh tapping will probably be required at an interval of from three to six months, perhaps more often.

Possible Complications.—This apparently simple and almost trivial operation is by no means free from risk, and the occurrence of complications has often led to discredit of the operator. We would urge sedulous care to secure asepsis, and that the operation should not be done unless the patient will rest quietly for some hours after it. The following are some of the occasional accidents that may result :

Some of the fluid may escape into the scrotal tissues and lead to a little œdema, which soon subsides. If a vessel be pricked, a considerable ecchymosis of the entire scrotum may result. If the trocar be blunt, or the cannula ill-fitting, or if the sac be thick, and the puncture be made in a hesitating manner, the tunica vaginalis may be pushed in front of the point of the instrument. Hæmatocele has in comparatively rare cases followed simple tapping. In such instances the testis may have been pricked, or has been the subject of disease, or the patient has engaged in active work directly after the operation. Occa-

sionally the sac fills with dark brown fluid exactly like tincture of iodine, except for the smell and chemical reaction. If a foul trocar be used, suppuration of the sac may follow, and this may prove fatal in old and weakly subjects.

Treatment by Injection.—The sac having been entirely emptied by tapping, the nozzle of a special syringe is applied to the cannula, and some irritant injected. The operation is most conveniently done while the patient stands, but if the patient is nervous or likely to faint he should be recumbent. Iodine and carbolic acid are the substances most frequently used for the injection.

Iodine.—The following solution may be employed :—Iodine, forty grains ; iodide of potassium, thirty grains ; water, one ounce. Neither the ordinary tinctura iodi nor the liquor iodi is strong enough for efficient use in the majority of cases.

From three to four drachms should be injected and retained, and be brought into contact with all parts of the sac by rubbing the walls together after the cannula has been removed. The puncture may be covered with a piece of strapping or a tuft of sterilised wool. Some surgeons inject a larger quantity of fluid, and allow half of it to escape after it has been brought well into contact with the interior of the sac. Mr. Jacobson injects two to three drachms of the tincture of iodine of the Edinburgh Pharmacopœia, and allows the whole to remain.

Little pain, or only a feeling of heat, may follow the operation. On the other hand, the pain may be severe and nauseating, and may spread to the perineum, the loins, or the neck of the bladder. The patient may faint.

Within twelve hours the scrotum will probably be swollen to its previous size, the parts are red and tender, and the reaction is attended with some fever. The patient should lie in bed with the scrotum well supported. He will probably have to keep his bed for four or five days, and then will have to wear a suspender for a considerable time. Some three or four weeks will elapse before the parts will be restored to their normal condition. The inflammation excited may be of so insignificant a degree as to produce no curative result. On the other hand, it may assume serious proportions, and call for the use of ice-bags and the free administration of opium.

We have noticed that the inflammatory swelling that follows the successful use of iodine injection is sometimes tympanitic on percussion

—an occurrence possibly due to the conversion of some of the iodine into vapour.

Carbolic Acid.—Five to thirty drops of pure phenol (liquid carbolic acid) are injected and left in the sac. The patient should rest for a day or two. The reaction varies much in different patients. From two to six weeks will elapse before the exudation is absorbed. In suitable cases it appears that three out of four will be cured by this method. It is claimed that carbolic acid excites less pain than iodine, and is more uniform and certain in its results.

Our personal experience with either iodine or carbolic acid injections is not large, as we prefer excision of the sac in every suitable case. But with regard to carbolic acid injections we have been struck with the variable results as regards amount of pain and reaction, and its extreme uncertainty as to cure. We have seen many permanent cures from the injection of tincture of iodine, but the method is far from being infallible, and the amount of pain caused is sometimes extreme. In fact, in some cases the patient after iodine injection is laid up or kept from business almost as long as if he had had an open operation.

Other injection materials are rectified spirit, and sulphate or chloride of zinc in solution.

Excision of the Parietal Part of the Sac.—This operation is the most certain to lead to a cure of the hydrocele, and conforms to the modern principles of surgery. It is doubtful by whom it was first introduced. Von Bergmann advocated it in 1885 (*Berlin klin. Woch.*, p. 209), though Mr. John Couper at the London Hospital was in the habit of performing it for some years prior to this date, and possibly many other surgeons as well. This method is especially adapted for hydroceles of the tunica vaginalis or of the epididymis in adults. Hydroceles of the cord are also best treated by excision, though in this case the entire sac is removed, whereas in hydrocele of the tunica vaginalis only the parietal portion is removed. It will be necessary here merely to describe the latter operation, which may be done under eucaine, though a general anæsthetic is usually necessary.

An incision about three inches long is made over the long axis of the hydrocele at its upper part, and is carried down

through the cremasteric layer. With forceps the tissues immediately covering the sac are peeled off on either side, whilst the hydrocele is pushed out of the wound as far as practicable. It is important to get right down to the sac, for it is easy to make the mistake of peeling off the tissues too soon. The sac itself will show the fluid immediately beneath it, and is often of a bluish colour, on this account. The vessels in the sac wall itself are insignificant, and for this reason it is advisable to strip off by blunt dissection the overlying layers. It is convenient not to open the sac until it has been well laid bare on either side. A puncture is then made and the fluid evacuated; the sac is laid freely open with scissors and then cut away. Care must be taken in doing this to keep just outside the epididymis externally and not to injure the vessels of the cord or the vas deferens internally. It should be remembered that in old hydroceles the body of the epididymis is often displaced from the testis by a pouch. Fig. 185 shows the relation of the upper part of the sac to the cord, etc., and indicates how much may safely be cut away. It is easy to destroy the epithelial covering on the testis by scraping it lightly with a Volkmann scoop, but it may be doubted whether this is necessary. In any case rough handling of the testis should be avoided. Any bleeding points are secured with pressure forceps, but ligatures are rarely required.

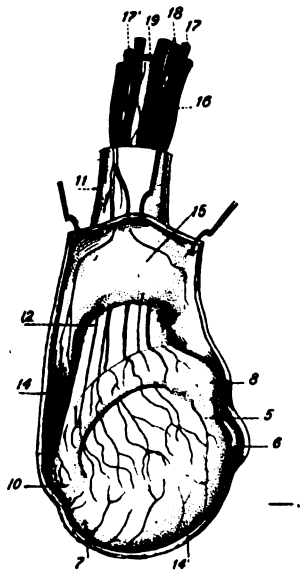


FIG. 185.—NORMAL RELATION OF THE TUNICA VAGINALIS TO THE TESTIS AND CORD, SHOWING THE AMOUNT OF THE SEROUS COAT TO BE EXCISED IN THE RADICAL OPERATION FOR HYDROCELE.

The operator should cut just outside the line of reflexion shown in this figure, with particular care not to damage the epididymis or vessels of the cord. 5, Junction of globus major with testis; 6, Hydatid of Morgagni; 7, Junction of globus minor with testis; 8, 14, 15, Tunica vaginalis, parietal layer; 10, Globus minor; 11, 12, Spermatic cord; 16, 17, 18, Anterior bundle of veins and spermatic artery; 19, Vas deferens; 17', Posterior bundles of veins. (*After Testut.*)

If oozing persists, a small drainage tube should be inserted at the lower angle of the wound, to be removed twenty-four hours later. Probably it is best to use drainage even if the divided tissues appear to be quite dry, as secondary oozing is so common after this operation. The sutures should be of fine silkworm gut, and should be placed close to the edges of the wound. The ordinary sterilised dressings are applied, and may be kept in place either by means of a T-bandage or, better, by a four-sided piece of linen to each angle of which is sewn a stout tape. These tapes pass round the abdomen and the thighs.

The patient need rarely be confined to bed more than five to seven days, after which time the stitches are removed and a suspensory bandage is worn. Complications of the operation are uncommon, though perfect asepsis is certainly difficult to obtain in this region. Slight orchitis sometimes occurs, but the greatest trouble is met with when the wound has been sewn up before hæmorrhage has ceased. For this reason the surgeon should have the organ brought well out into the wound during the excision of the sac, and should not return it until the bleeding has practically ceased.

Incision and Eversion of the Sac.—This method was introduced by Lieut.-Col. J. J. Pratt in 1898, and to some extent superseded other methods in India, besides being largely employed in this country. The tunica vaginalis is incised in front, the fluid completely emptied, the testis is then brought through the incision so as to turn the hydrocele sac inside out. At first a few sutures were used to unite the edges of the everted sac behind the cord, but these were found to be unnecessary, and are now dispensed with.

The method appears to be very successful in simple cases where the hydrocele is of moderate size, and its wall not much thickened. At the same time there can be no objection to excision of the redundant sac wall, and without this a pouch is left above the testis in some cases, which may cause recurrence. We consider eversion of the sac to be much inferior to its excision, as regards the permanence of cure, and as both involve making

a wound through the scrotum we strongly advise the more radical method to "turning the sac inside out."

Selection of Operation.—In deciding on the method to be employed, it should be noted that injection with iodine, though still largely employed, is by no means certain to cure. In many cases recurrence has taken place. Moreover, there is a good deal of pain attached to this method, more than is experienced after excision of the parietal layer.

The treatment by simple incision and drainage of the sac cannot be recommended, for the following reasons :—

1. It is uncertain in its results—probably more so than injection with iodine.

2. For success it depends upon the drainage exciting inflammation and probably suppuration of a serous cavity. This is opposed to all modern principles.

3. The after-treatment is slow and irksome.

The only advantage it offers is the fact that a general anæsthetic may usually be dispensed with at the time of the operation.

The choice of procedure for ordinary cases of hydrocele in adults will lie between carbolic acid or iodine injection, and excision of the parietal layer of the sac.

Excision of the sac should certainly be practised under the following conditions : a hydrocele of long standing with thickened wall or sanguineous contents ; one of excessive size ; or one in which injections have been tried and failed.

It may sometimes be performed under local anæsthetics (eucaine or cocaine, with due precaution as to the dose employed), especially when the hydrocele is small—*e.g.* those of the epididymis.

It has often been done under spinal analgesia. We recommend, however, a general anæsthetic for most cases.

The treatment of a large hydrocele in an elderly subject should not be lightly undertaken by the surgeon, as a fatal issue has been known to follow even tapping under such conditions.

A large number of cases of hydrocele in children, as well as in adults, require no active surgical measures.

CHAPTER XXVII

EXCISION OF THE TESTIS

THE term castration should only be applied when both testes are removed. This procedure is but rarely required, and from the well-known effects upon the mental condition, etc., of the patient that are apt to follow it should be avoided if possible.

Indications for the Operation.—Excision of the testis and epididymis with high division of the spermatic cord is called for in the following cases :—

1. Sarcoma or carcinoma, provided no evidence of secondary deposit exists within the abdomen.
2. Tuberculous disease which is extensive and threatening to break down. In some cases erasion (*see* p. 687) may be substituted for complete excision.
3. Tertiary syphilitic disease which has resisted thorough treatment, and where the condition has become a serious trouble to the patient.
4. Exceptional cases of hæmatocele or of innocent tumour such as enchondroma.

Excision of both testes (castration) was extensively performed a few years ago in cases of enlarged prostate, but the procedure has been completely abandoned in favour of prostatectomy. It has also been advocated with amputation of the penis in cases of epithelioma of the latter organ, but is rarely if ever to be advised in these circumstances.

Preliminary Preparations.—It is important to ascertain whether a hernia is present on the side to be operated on. If so, the inguinal canal should be laid open at the time of operation and a radical cure of the hernia performed.

On the day before operation the patient's bowels are thoroughly

cleared. The entire pubic region and the groin are shaved, and the scrotal hair cut off. All the parts are rendered as clean as possible by repeated washing with soap and hot water; an antiseptic compress is then applied. The delicate scrotal skin will, however, not tolerate free use of strong antiseptics.

Instruments required.—Two or three scalpels; straight and curved scissors; several pairs of Wells' artery forceps; dissecting forceps; a clamp for the cord; blunt hooks; needles and needle-holders; catgut or fine silk ligatures; silkworm-gut sutures.

The clamp is the only special instrument required; a large Wells' pressure forceps or an intestinal clamp (as used in gastro-jejunostomy) will answer the purpose.

Position of the Patient, etc.—The patient lies on his back with the thighs extended, and a little apart. The penis is wrapped in sterilised gauze, sterile moistened towels are packed between the thighs, and so arranged over the abdomen and thighs as to isolate the region of the testis and groin. The skin in this immediate region is now treated with alcoholic antiseptic—with care taken that the latter does not run under the towels so as to cause irritation. The exposed area is carefully dried with sterile swabs before making the incision.

The testis is well raised by the packing between the thighs; it is steadied by the assistant's hand, which pushes it forward and thereby stretches the skin over it. Some operators prefer to use their own left hand for this purpose.

The Operation.—The actual incision will vary according to the case. Whilst there is no reason for preferring a short one, it is yet an advantage not to prolong it to the bottom of the scrotum if that can be avoided. The scrotal skin cannot be rendered truly aseptic nor can any dressing be kept in accurate contact with a scrotal wound. Hence, if the diseased organ is of reasonable size and free from sinuses or adhesions in the scrotum, the operator places his incision high up towards the external ring, making it just large enough to allow of the testicle

being protruded. A subsequent puncture is made at the bottom of the scrotum for a small drain.

Often, however, there are areas of diseased scrotal covering infected from tubercular epididymitis, or if the case is one of tumour there may be suspicious adhesions, or the bulk may make a long incision necessary. There should then be no hesitation about prolonging the wound downwards.

A vertical incision is carried from a point about one inch below the external abdominal ring to the bottom of the scrotum.

When the skin is involved by the growth, or when it has become adherent to the testis or is the seat of sinuses, two elliptical incisions that clear the affected skin and meet above and below should be made. The position of these elliptical cuts must obviously depend upon the position of the implicated skin, and they may have to be made upon the lateral or even the posterior aspects of the scrotum. In dividing the tissues between the skin and the tunica vaginalis, the soft parts should be gently moved to and fro by the left hand, which still keeps its position on the scrotum. The mobility of the superficial layers is striking, but the tunica as it is approached is recognised by its perfect immobility.

When the skin is involved, this means of noting the progressive depths of the incision is lost.

The testis may be removed without opening the tunica vaginalis. In such case the tunica, as a simple bag, may be separated from the scrotal tissues with the fingers. While this is being done, the assistant should hold the scrotum and the testicle of the opposite side. In a large number of cases, however, it is desirable that the tunica should be opened : either for diagnostic reasons, or to lessen the bulk of the swelling when the sac is distended with much fluid.

The testis is now shelled out of the scrotal tissues with the fingers, aided by the curved scissors or the scalpel. Any bleeding vessels should be at once secured by Wells' forceps. The " scrotal ligament," a band of connective tissue connecting the globus minor and the tunica vaginalis with the scrotum, will probably

require division. This done, the operator clears the organ from below upwards, taking care to keep in the right plane, *i.e.* external to the cremaster layer.

In exposing the tumour, care should be taken not to cut into it. The operation is complicated by opening an abscess cavity or a cyst, or by cutting into a mass of soft growth.

The cord is now well isolated with the fingers, and drawn down. This will be rendered easier by cutting through the inner band of origin of the cremaster muscle. It is then secured by a clamp. The best clamp for the purpose is a Spencer Wells' large pressure forceps. The assistant holds the clamp, and the surgeon, grasping the testicle, divides the cord with the knife about three-quarters of an inch below the clamp. The vessels of the cord can now be separately secured. It is impossible to distinguish the arteries from the veins. The mouths of the latter vessels gape when grasped by the clamp; they are thereby rendered obvious, and are readily secured. Both veins and arteries are picked up with artery forceps, and secured with catgut. The two sets of veins should be tied separately. Three or four ligatures may be required, but very seldom more.

These ligatures should preferably be of catgut and not of silk, for fear of a troublesome sinus resulting. Silk ligatures buried in the scrotal tissues in such operations are almost invariably thrown off in the end. They should be knotted very securely before the clamp is relaxed, and should be left long until it is seen that all the vessels have been well tied.

Any bleeding points in the scrotal incision must be secured. The following vessels are divided—superior and inferior external pubic, superficial perineal, and the artery to the scrotal septum. Most of the bleeding is venous, but whether from arteries or veins it should all be controlled by ligatures before the wound is sewn up.

In applying sutures, it is best to use fine silkworm gut. In order to obtain an even line of union, the edges of the incision should be stretched between two blunt hooks, inserted at the

extremities of the wound and held by the assistant. This will prevent the in-turning of the edges of the incision, due to the contraction of the dartos, and will allow of accurate adjustment of the parts. It is well to introduce all the sutures before tying the first one. A drainage tube one inch and a half long may be secured by means of the last suture, or if the high incision has been used a separate opening is made at the bottom of the scrotum for a special drain.

After-treatment.—The scrotum is well slung up by a light roll of moist sterilised gauze applied as a suspender. This gauze clings to the skin better than any other dressing. The wound is then dressed with more gauze, and over this cyanide or plain sterile wool. A muslin or open-wove bandage in the form of a double spica round both groins will answer better than a T- or any form of suspensory bandage.

A single turn of elastic webbing bandage and some pink jaconet to prevent contamination of the dressings with urine complete the dressing.

If this be properly applied, the pad exercises firm but gentle pressure upon the wound. The drainage tube should be removed in twenty-four hours, and the dry dressing continued.

In the first twenty-four hours or more after the operation retention of urine may exist.

Should suppuration occur, constant care must be taken to prevent bagging.

The sutures are removed on the fifth to the seventh day. The patient may possibly complain of the hard, tender swelling which sometimes appears at the external ring, and which is due to inflammatory changes in the stump of the cord.

As the wound heals, the cicatrix becomes depressed, from the obliteration of the scrotal pouch.

If primary union be not obtained, the edges of the wound may need to be retained in contact by strapping.

Comment.—In some cases the descent of a hernia after castration has forced open the wound, the rupture having been previously kept up by the enlarged testicle. During the opera-

tion, moreover, hernial sacs have been inadvertently opened up. If a scrotal hernia exists, the rupture should be reduced, the sac excised, and its neck ligatured. The procedure is described in the section on the Radical Cure of Hernia (p. 339).

When the skin incision is carried to the bottom of the scrotum the intention is to secure good drainage.

It has already been noted that the higher up the incision is placed, the more easy is it to avoid septic contamination, and that unless the testis is of great size, it is possible to remove it through a moderate incision made near the external ring. The bottom of the scrotum may then be drained for twenty-four hours through a separate puncture.

When the skin is implicated by the disease, the incisions should extend beyond the diseased area, and involve sound skin only.

It is not necessary to remove redundant skin, unless it be excessive in amount and much atrophied.

If any sinuses be left behind, as after the removal of a tuberculous testis, they should be most carefully scraped with a Volkmann spoon. The cord is usually clamped and divided just below the external ring. It can seldom be necessary to open up the whole inguinal canal to secure the cord, as advised by some. If a new growth has extended to the external ring, the expediency of any operation may be questioned. Before the cord is secured and divided, the anæsthetic may be discontinued for a while, as the section is sometimes attended by a very marked and possibly alarming sinking of the pulse.

It is to be remembered that the cord is very much dragged down by a large growth ; and if secured very high up, the stump, after section, may be withdrawn beyond easy reach when the heavy tumour is removed.

The chief bleeding to be feared after castration cases is venous rather than arterial.

It is unwise to include the cord in one ligature ; the vessels are not well secured by this means. The loop of thread may slip off when the clamp is removed. A substantial ligature (if single) must be employed, and it is too apt to excite suppura-

tion until it is discharged. Secondary hæmorrhage may follow the loosening of the single ligature. Neuralgia of the cord may also attend the procedure.

The same objections apply, but in a less degree, to the practice of transfixing the cord with a needle, and ligaturing it in two segments.

Sometimes a tuberculous or syphilitic testis has to be operated on in which suppuration has already supervened, and the parts are thoroughly septic. In such a case, although all possible precautions are taken at the time of operation, the surgeon can hardly hope for primary union, and free provision for drainage should be made. Mr. W. Thorburn (*Brit. Med. Journ.*, Jan. 16th, 1904) advocates the making of two separate incisions. The upper incision is placed over the inguinal canal, which is freely opened, and the cord severed as high as possible after careful ligature of its vessels. The internal oblique may be divided as well as the external. This wound is sewn up, the proceeding being carried out whilst the scrotum is still invested with an antiseptic compress. The testis is then exposed through a low incision, and the divided cord drawn downwards, the wound being closed in the usual manner. Even if it suppurates the upper wound over the inguinal canal may heal soundly.

Excision of Vas Deferens and Vesicula Seminalis in Tubercle.—In nearly all cases of tuberculous orchitis the vas is invaded with tubercle bacilli along its whole course by the time the patient consents to operation. Owing to this fact, a troublesome complication after removal of the testis is the development of a secondary lump or abscess round the severed end of the vas. This may occur weeks or months after the wound has apparently healed.

Partly to avoid this, and also to make a complete clearance of all the tuberculous disease, the plan has been carried out of removing the lower end of the vas and the corresponding vesicula seminalis by the perineal route, whilst the other end is pulled away with the testis through an incision prolonged into the inguinal canal. Reverdin and other surgeons have proved that

it is thus possible to remove the whole length of the vas, but the proceeding is one of considerable difficulty and of very doubtful value. The perineal part of the operation, conducted through a curved incision made in front of the rectum and across the median raphe, is similar to and even more difficult than perineal prostatectomy. The vas and vesicula have to be reached at the bottom of a deep and narrow wound, there is apt to be most troublesome venous hæmorrhage, and there is some risk of damaging the bladder wall (to which the vesicula is closely bound by the recto-vesical fascia) or the ureter. Finally, the wound is placed very badly for aseptic purposes. To drag the greater part of the vas deferens out through the inguinal canal is also a rough and hazardous procedure. When it is added that tuberculous disease of the vesical neck or prostate is often present at the same time as the disease of the vas deferens, and that spontaneous recovery from both is not infrequent, the arguments in favour of combined perineal and inguinal operations are seen to be but feeble. The operation was described in the *Gazette des Hôpitaux*, Oct. 15th, 1898, and also in the *Bull. de la Soc. Anatomique*, 1898, p. 603.

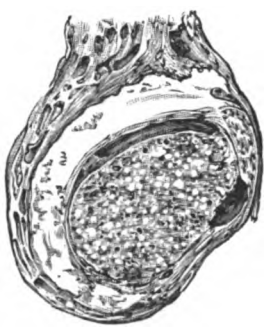


FIG. 186.—TUBERCULOUS DISEASE OF THE TESTICLE. (*London Hospital Museum.*)

Mr. Rickman Godlee (Bradshaw Lecture, Dec. 14th, 1907) endorses the conservative view given above, whilst perhaps underrating the difficulty of the operation. Speaking of tuberculous disease he writes: "Removal of the vesicula, either by a posterior or a perineal incision, is not difficult *and is not to be recommended.*"

Erasion of the Tuberculous Epididymis.—In removing the whole organ the surgeon is often taking away much more than is actually diseased, for in the majority of cases the testis proper will be found to be free from tubercle. It is the epididymis and the vas which are involved with so-called "crude tubercle,"

whilst occasionally the testis becomes affected with miliary deposit. Hence a very thorough erasion and excision of all the tuberculous foci will often suffice, and the testis itself may be safely retained. We have operated in some cases in which the whole epididymis and several inches of diseased vas deferens were excised. The patients on whom epididymectomy was thus performed have some of them been followed up for years,

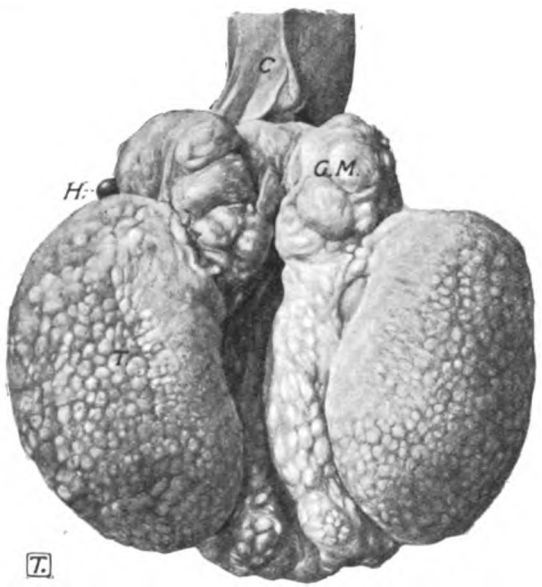


FIG. 187.—VERTICAL SECTION OF TESTIS AND EPIDIDYMIS EXCISED FOR TUBERCULAR DISEASE.

C., Spermatic cord; G.M., Globus major; H., Hydatid of Morgagni. The whole of the testis (*T.*) is studded with miliary tubercle. In such a case erasion would be insufficient, complete removal is necessary.

and the testis on the operated side has been found to retain a good consistence, and has not developed tubercle. But in these patients there is the well-known tendency for the opposite epididymis, etc., to become later diseased.

The Operation of Erasion.—The skin of the scrotum being rendered as nearly aseptic as possible, a free incision is made, and the whole testis brought out through this on to sterile gauze. The tunica vaginalis is then opened up, and the limits of the

disease ascertained. If small nodules are felt or seen beneath the visceral layer, *i.e.* in the testis proper, the case is not one for erasion, and complete excision should at once be performed. But if all the appearances point to the tubercle being limited to the epididymis (and vas), every particle of diseased tissue should be cut or scraped away. Some inches of the vas may require removal. In the manipulations the testis itself may be steadied by the assistant's hand, but the less it is exposed to trauma the better. The whole of the epididymis, from the globus major to the vas, must be excised. Care should be taken not to damage the main vessels of the cord, and if this be avoided, the hæmorrhage will only be slight. Finally, the testis and its vessels are replaced in the scrotum, and a small drainage tube left in the wound for a few days.

Provided the testis has not been squeezed or grasped by forceps during the operation it is surprising how little effect upon its nutrition follows. Of course it is useless as a procreative organ, but the " internal secretion " is preserved, and considerable importance must be attached to this, especially if the organ is the only remaining one at the time of the operation. Moreover, as Rickman Godlee observes, " the moral effect of an empty scrotum is not to be overlooked."

CHAPTER XXVIII

AMPUTATION OF THE PENIS

THIS operation is required principally for cases of epithelioma. The disease commences almost invariably on the glans or the inner surface of the prepuce, and leads to secondary deposits in the inguinal glands before either the corpus spongiosum or the corpora cavernosa are much involved. Hence, as a rule, amputation of the free portion of the penis, leaving a stump of the organ, with simultaneous removal of any inguinal glands that are abnormally large or hard, should be the operation of choice. A method of removing the entire organ, including the whole of the corpora cavernosa, will be described; but it should be understood that not only is it rarely required, but that it affords a greatly inferior result so far as the patient's comfort and the risk of stricture are concerned.

Epithelioma of the penis is a purely local form of cancer, and the results of early operation are most satisfactory as regards prospect of cure. It is a mistake to suppose that the disease tends rapidly to spread backwards along the urethra or the cavernous tissue of the organ.

With regard to its amputation, the following points must be attended to:—

1. The stump should be provided with a flap of skin from the dorsum, and primary union secured as carefully as in amputating a limb. All methods involving the use of an *écraseur* or cautery should be entirely abandoned, and hence need not here be described.
2. An elastic tourniquet should always be used, and the vessels likely to bleed should be carefully ligatured

before it is removed. These vessels are two dorsal arteries, on either side of the dorsal vein, an artery in the centre of each corpus cavernosum, two small ones in the corpus spongiosum, and two or more veins in the subcutaneous layer. Their position is shown in the diagram from Testut (Fig. 188).

3. The corpus spongiosum must be divided at least half an inch further forwards than the corpora cavernosa. The end of the urethra must be brought through an aperture in the dorsal flap, notched and sutured with the mucous membrane everted so that there is no risk of a stricture ensuing. This most troublesome result was common after amputation of the penis, but in a long series of cases operated on by us of late years, the only one in which stricture followed was one in which the Thiersch-Gould method was employed. In this case the perineal meatus had narrowed to pin-point dimensions in the course of a year, and a fresh operation had to be performed.

Instruments Required.—For the operations to be described the following instruments are needed: An elastic band tourniquet or rubber catheter; hare-lip pins; a gum-elastic catheter; a scalpel; a narrow straight bistoury; straight and curved scissors; a tenaculum; dissecting, toothed, and artery forceps; small curved needles and needle-holder for the urethra; straight needles; a periosteal elevator; sutures; ligatures.

Amputation of the Free Portion of the Penis by Dorsal Flap.—The hair about the root of the penis having been shaved off, the parts are rendered as aseptic as possible in the usual way. The patient lies in the usual position, with the thighs slightly abducted; the surgeon stands on the right side of the patient. Previous to the operation the rectum and bladder should have been emptied. An elastic tourniquet—a No. 9 soft rubber catheter answers admirably—is tied around the root of the penis. The tourniquet may be prevented from slipping forward by

applying it behind a sterilised hare-lip pin used to transfix the penis.

The end of the penis is then held by an assistant with forceps, and a rounded dorsal flap of skin and fascia shaped out and dissected up. This flap must be of sufficient dimensions to cover the whole section of the penis, and it should be made well behind the edge of the epithelioma. The flap being held back, the penis is transfixed with a narrow-bladed sharp bistoury

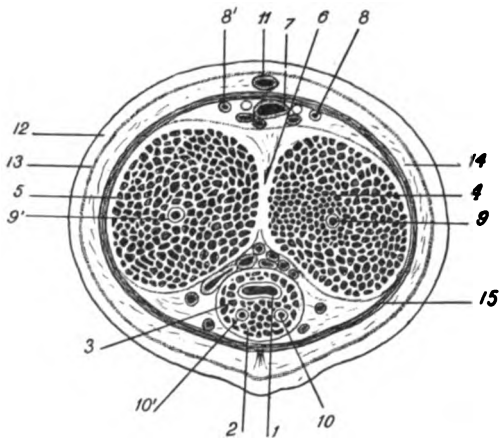


FIG. 188.—SECTION OF PENIS SHOWING THE VESSELS REQUIRING LIGATURE IN AMPUTATION THROUGH THE ORGAN. (*From Testut's Anatomy.*)

1, Urethra; 2 and 3, Corpus spongiosum; 4 and 5, Corpus cavernosum; 6, Median septum; 7, Dorsal vein; 8 and 8', Dorsal arteries; 9 and 9', Artery of corpus cavernosum; 10 and 10', Arteries of corpus spongiosum; 11, Additional dorsal vein beneath skin; 12, Skin of penis; 13, Dartos layer; 14, Cellular tissue; 15, Fascial sheath.

between the corpus spongiosum and the corpora cavernosa. In order to guard against the risk of injuring the roof of the urethra with the knife, it is well to have introduced a catheter before transfixion. The blade of the knife is then turned upwards, and the two corpora cavernosa are divided at the level of the base of the skin flap.

The urethra is now dissected out for nearly an inch in front of the point where the knife was introduced, and severed at this level. The skin on the under-surface of the penis is divided transversely from one end of the dorsal incision to the other.

There has been hitherto no hæmorrhage, and before removing the tourniquet all the chief arteries and veins are carefully secured with catgut ligatures. The tourniquet is now removed, and any bleeding points are dealt with.

A small incision is made through the dorsal flap, and the stump of the urethra drawn through this opening; the end of the urethra is notched on both sides, so that it can be everted and sutured all round to the margin of the opening in the flap. The edges of the latter and of the skin below are then sutured. Either fine silk or catgut may be used—the latter has the advantage of not requiring subsequent removal. It is difficult to keep any dressing applied, and none is really required. Some boric powder may be dusted on. It is well to leave the ends long of two of the sutures which secure the new meatus, as they facilitate the passage of a catheter during the next day or two. However, as a rule, the patient will be able to pass his urine without an instrument. It will be seen that by this method no raw surface is left, requiring slow cicatrisation with its attendant risk of stricture. Healing is therefore rapid, and the patient need not be kept in bed for more than a week or so. One point in the operation is of special importance: to take plenty of time in securing all bleeding vessels before the flap is sewn down. The use of the tourniquet is essential. If any lymphatic glands in either groin are enlarged, they should be excised at the same time as the amputation of the penis. This is done through an oblique incision on one or both sides, the cut running parallel with Poupart's ligament.

Removal of Inguinal Lymphatic Glands.—In cancer of the penis it is as a rule easy to remove thoroughly the primary disease; the danger of recurrence should rarely lie in the stump of the penis, but there is grave risk of recurrence in the glands of either groin. Theoretically, then, a complete operation should include removal of the inguinal glands on both sides with amputation of the penis. We have performed this in several cases, but we doubt if any surgeon makes a routine procedure of such an extensive operation. If the patient be stout, and no glands

can be felt, the excision of the inguinal and upper femoral groups is far from easy or satisfactory. Moreover, from the number of large lymphatic vessels divided, primary union of the wounds is exceptional. Probably the best course to adopt is the following: A careful examination should be made of each groin, and if there are suspicious glands to be felt the whole group with the surrounding fat should be removed through an incision extending the length of Poupart's ligament. The deep aponeurosis, the spermatic cord, and the sheath of the femoral vessels are laid bare in this operation. If, on the other hand, no enlarged or hard glands can be felt, the operator will limit the operation to the penis, insisting on the patient coming up for examination from time to time during the next twelve months.

Amputation of the Entire Penis.—The best procedure for the removal of the entire penis is that devised by Prof. Thiersch and Mr. Pearce Gould (*Lancet*, vol. i., 1882, p. 821). It ensures a very complete removal of the diseased organ. The new opening of the urethra is well established. There is no risk of an infiltration of urine into the tissues of the scrotum, and the skin of the part is not irritated by the trickling of urine over it.

The operation is performed as follows :—

The patient having been placed in the lithotomy position, the skin of the scrotum is incised along the whole length of the raphe. With the finger and the handle of the scalpel the two halves of the scrotum are then separated, quite down to the corpus spongiosum. A full-sized metal catheter is now passed as far as the triangular ligament, and the knife is inserted transversely between the corpora cavernosa and the corpus spongiosum.

The catheter having been withdrawn, the urethra is cut across. The deep end of the urethra is then detached from the penis quite back to the triangular ligament. An incision is next made round the root of the penis, continuous with that in the median line; the suspensory ligament is divided, and the penis separated, except at the attachment of the crura. The knife is now laid aside, and with a stout periosteal elevator,

or rugine, each crus is detached from the pubic arch. This step of the operation involves some time, on account of the very firm union of the parts to be severed. Four arteries—the two arteries of the corpora cavernosa and the two dorsal arteries —require ligature.

The corpus spongiosum is slit up for about half an inch, and the edges of the cut are stitched to the back part of the incision in the scrotum.

The scrotal incision is closed by sutures, and a drainage tube is so placed in the deep part of the wound that its ends can be brought out in front and behind. No catheter is retained in the urethra.

This operation has been combined with double castration by some surgeons. In ordinary cases of epithelioma these extensive operations are not justifiable; they involve needless mutilation. The tendency of epithelioma to spread backwards along the crura penis is very small in comparison with the frequency of secondary deposits in the inguinal lymphatic glands.

CHAPTER XXIX

OPERATIVE TREATMENT OF SCROTAL ELEPHANTIASIS

THE question of operation in cases of elephantiasis of the penis and scrotum is admirably discussed by Dr. McLeod, of Calcutta, in Heath's "Dictionary of Surgery" (vol. ii., page 399).

Mere bulk is no bar to operation, as tumours weighing 100 to 120 lbs. have been removed with success.

The following are the chief contra-indications to operation: old age; organic disease of the heart, kidneys, or intestines; anæmia; diabetes; recent and acute enlargements of the liver or spleen; incurable urethral fistulæ; the existence of large herniæ.

Before the operation any stricture of the urethra should be relieved, and abscesses and sinuses cured.

The main points in the operation are—rapid execution, the removal of every trace of the disease, the prevention of bleeding, the preservation of the essential parts of the organs of generation, and the encouragement of rapid healing.

The Operation is thus described by Dr. McLeod:—

The patient is placed in the recumbent posture and anæsthetised. To render the tumour anæmic, the mass is elevated and compressed by an elastic bandage for ten to twenty minutes, according to the size of the mass.

To prevent bleeding during the operation, an elastic cord about three feet long is taken, and the centre of it is passed round the loins, the ends are brought over the brim of the pelvis, are crossed twice over opposite sides of the neck of the tumour, and finally are brought together below the navel. The neck of the tumour will thus be tightly embraced by two turns of the cord on each side, crossing each other on the pubes, and just in front of the anus.

No portion of diseased tissue must be left behind. Even although the prepuce appears to be healthy, it should be removed close to the

corona ; and as thickening is peculiarly apt to commence in the raphe of the perineum, that part should, in most cases, be freely removed by a V-shaped incision up to the verge of the anus. If any attempt is made to cover the penis and testes with flaps, these should be taken from the skin of the abdomen or thighs, and not from the neck of the tumour ; but a satisfactory result can be secured in all cases without resort to flaps, which are prone to slough and suppurate.

The first step consists in decorticating the penis. The prepuce is slit up, and a skin incision continued from this slit along the whole dorsum of the penis to the root. The penis is then freed by finger and knife, the mucous membrane of the prepuce being carefully detached at the line of its reflexion. The isolation of the penis is completed as far as its suspensory ligament, which should not be injured. A vertical incision is now made from the pubes to the fundus of the tumour, over one cord and testis. By successive bold strokes these are exposed, and then dissected out by fingers and knife, and subsequently held out of the way by an assistant. The other testis is similarly dealt with. The three vertical incisions are then connected at their pubic terminations by two transverse cuts, which must be beyond the limit of the diseased tissue.

A circular or oval incision is now made round the rest of the circumference of the neck of the tumour, and by rapid strokes the whole mass is removed. Vessels are then looked for. The largest will be found in the centre of the perineum and on each side of the pubes. By gradually loosening the cord, others will be observed to spring. As many as thirty or forty ligatures may be required. The parts may now be trimmed, if any diseased tissue has been left behind. The testes may next be stitched together by means of catgut, and fastened in proper position by sutures of the same material. Depressions or pockets can be very easily made for their reception, by separating the deep layer of the superficial perineal fascia from the subjacent fat and areolar tissue. The skin can then be drawn over them from each side to a considerable extent by means of a continuous catgut suture.

The prevention of putrefaction in such an extensive wound is difficult. Free and frequent irrigations and careful drainage must be persisted in. Dr. McLeod is in favour of the use of boric dressings.

The wound fills up by granulation, and the process of repair occupies from six weeks to two months. Care must be taken to keep the penis free, as it is apt to become embedded in the mass of granulation tissue.

The ultimate result of the operation is in the great majority of cases satisfactory. Skin is dragged by the process of cicatrisation from the thigh to form a seemly substitute for the scrotum, and the penis acquires a fresh covering of epidermis. The sexual functions are restored, and both health and comfort re-established.

If the skin of the penis is quite healthy, the scrotum may be removed alone by a circular incision round its neck, the testes being dissected out as the incision is deepened.

CHAPTER XXX

CIRCUMCISION

In performing the operation for a redundant prepuce, the following method will be found convenient :—

The Operation.—The end of the penis is lightly seized with a pair of circumcision or dressing forceps. The forceps are so applied that their lower margins fall exactly across the line of the corona. As the blades are closed the glans slips out of the way, and at last nothing is held but the prepuce. The size of forceps employed must vary with the age of the patient. They should hold the skin firmly and squarely.

As the glans slips out of the grip of the forceps, the skin at the orifice of the prepuce may become turned in, and too much of the integument of the penis be drawn between the blades of the instrument. To avoid this, the foreskin should be firmly held with a pair of sharp-toothed forceps, which are applied at the preputial orifice, exactly where the skin and mucous membrane join. They serve to keep the prepuce in position while the clamp forceps are acquiring a hold. As already stated, the latter are applied exactly along the line of the corona ; they will thus, when fixed, be obliquely placed with reference to the long axis of the penis.

More skin is removed from the dorsal than the frænal aspect of the part. To ensure a most correct adjustment of the forceps, a mark may be made with a dermograph pencil on the skin of the penis, precisely around the line of the corona, as the parts lie before being disturbed. When the blades are closed this coloured line should not be visible beyond them. In infants forceps are not required, the prepuce being grasped by the thumb and fore-finger.

The skin being now put upon the stretch by drawing on the forceps (if forceps are used), the prepuce is divided with a fine straight bistoury just beyond the forceps blades—*i.e.* on the distal side of the latter.

The mucous layer left behind is now slit up along the dorsal median line. This is best done with straight scissors, while the membrane is held with toothed forceps. The slit must go well back to the corona. The two flaps of mucous membrane are now stripped off the glans until the corona is reached. The membrane is often very adherent, and has to be forcibly peeled off by forceps and a director. Any collection of smegma preputii is removed. A narrow cuff of mucous membrane must be preserved in order to suture it to the skin. Some operators do not remove any of the mucous membrane, but this we think is a mistake. In infants no sutures are required ; and as no bleeding points will require attention, the operation is complete. In lads and adults the cut edges of the mucous membrane and skin must be united by sutures. The finest catgut should be employed, and should be inserted as close as possible to the free margins of both the skin and the mucous membrane. If this is done, the sutures will cut their way out, and need not be removed unless they are still retained on the seventh day. Not more than three suture points on each side will be required.

In adults there may be free bleeding, and all obvious vessels should be ligatured with fine catgut. It is the arteries on either side of the frænum that have caused troublesome secondary hæmorrhage after circumcision.

The wound is best dressed with a narrow strip of sterilised lint, which is secured around the penis.

A strip of dry cyanide gauze wound several times round and secured by celloidin or collodion answers equally well. Of course the fixative must not be applied over the whole of the gauze, as its contraction would cause trouble.

By the use of the dry dressing oozing is checked ; and as the lint sticks to the part, the wound edges are kept in contact.

Oiled dressings of any kind are objectionable. The dressing slips about, and is very apt to come off.

The first dressing is left untouched for twenty-four or thirty hours; it is then allowed to soak off as the patient sits in a warm hip-bath.

Dry lint or gauze make, we think, the best dressing throughout the case. The patient—if an adult—should remain in the recumbent position for two or three days, and should not move about much until the part is nearly healed. He should have a warm hip-bath on the third or fourth day, and after that, if possible, every night and morning. On each occasion the wound is re-dressed.

It is important that no tight band should surround the penis, since the extremity may become congested and œdematous. As the patient lies in bed, the penis must be kept supported, and not allowed to hang down. A cradle will be required. In infants, the following method of dressing the wound—as proposed by Paul Swain—will be found very convenient (Heath's "Dictionary of Surgery," vol. i., p. 308):—

"A long strip of dry lint, six or eight inches long and half an inch wide, is applied as follows:—The glans being well pulled forward by an assistant, the middle of the strip of lint is applied to the under-surface of the penis, immediately behind the glans. The two ends are then passed over and around the organ in successive turns until the root is reached, when they will lie crossed on the lower part of the abdomen, and must be secured in that position by a couple of strips of adhesive plaster. The orifice of the urethra is thus left free, the cut edges of the mucous membrane and skin are retained in apposition, and the child is unable to pull off the dressings."

Often a good deal of thickening remains about the frænum, and there may result therefrom a permanent lump. This is entirely due to the leaving of too much tissue about the frænum. It is to a great extent avoided if the wound line faithfully follow the corona. It is a common mistake to divide the prepuce in a line at right angles to the long axis of the penis.

In adults in whom the preputial orifice is very narrow, but the foreskin itself is not unduly redundant, a modified operation is sometimes resorted to. A director is thrust under the prepuce, and carried well back to the corona. A narrow curved bistoury with a sharp point is made to follow the director, and the point to pierce the skin at the level of the corona. The foreskin is thus slit up along the median dorsal line. The mucous membrane is peeled back, the two flaps are rounded off, and the cut edges are united by a few suture points, as in the more complete operation. It should, however, be noted that incomplete operations —either forcibly stretching the prepuce or slitting it up by a linear incision—are, as a rule, disappointing, and usually end in a proper circumcision being done later.

Local anæsthesia by means of eucaine or cocaine injections answers fairly well for circumcision in adults. An elastic tourniquet should always be used under these circumstances, since it prevents risk of toxic absorption. The solution used need not be stronger than 1 or 2 per cent.

As a general rule it is preferable to give a general anæsthetic. Local anæsthesia has two drawbacks: first the injections cause swelling of the whole prepuce, secondly with these thorough cleansing of the skin is not so likely to be performed, and hence asepsis is not secured. Suppuration after circumcision is a most troublesome complication, as healing will be greatly delayed. Hence we strongly advise the use of a general anæsthetic, with every precaution to make the operation area aseptic.

CHAPTER XXXI

OPERATIVE TREATMENT OF HÆMORRHOIDS

Anatomy of the Rectum.—The rectum is divided into two parts, the rectum proper and the anal canal.

1. *The Rectum.*—This is the comparatively dilated portion which extends from about the level of the third sacral vertebra, where the pelvic meso-colon terminates, to the attachment of the levator ani where the anal canal commences, 1½ inches in front of the tip of the coccyx and 1½ inches from the anus. Its length is from 5 to 6 inches.

It is entirely destitute of mesentery and has no sacculations. When seen from the front three curves are noticed—two with their concavities directed to the left, and the third (the middle one) with its concavity directed to the right, the concavities forming prominences on the inner wall of the rectum, the rectal valves. When seen from the side two curvatures are noticed, an upper larger one with its concavity forwards, which fits into the cavity of the sacrum, and a lower smaller one with its concavity backwards, embracing the ano-coccygeal body. The longitudinal muscle fibres are thick and are present all round.

Peritoneal relations.—The rectum is only partly covered with peritoneum. In the upper two or three inches the covering is complete, it then gradually leaves first the posterior and then the lateral aspects, and later is reflected from the front wall also, to pass to the bladder in the male and to the vagina in the female, so that the lower third has no covering of peritoneum. The pouch formed by its passage to the bladder in the male is known as the *recto-vesical pouch*, the corresponding pouch in the female between the vagina and rectum being the *pouch of Douglas*. The point of reflexion averages 3½ inches from the anus. The fossæ formed by the peritoneum on either side by its reflexion from the rectum to the posterior wall of the pelvis are known as the *pararectal fossæ*.

General relations.—Behind the rectum is closely connected by areolar tissue with the front of the sacrum and coccyx, and below these with that portion of the pelvic floor formed by the meeting of the two levatores ani to form the ano-coccygeal raphe: when distended it may lie on each side on the pyriformis and sacral plexus. The two chief branches of the superior hæmorrhoidal artery lie behind in the upper part, but lower down they pass to the sides. Laterally it is above in relation-

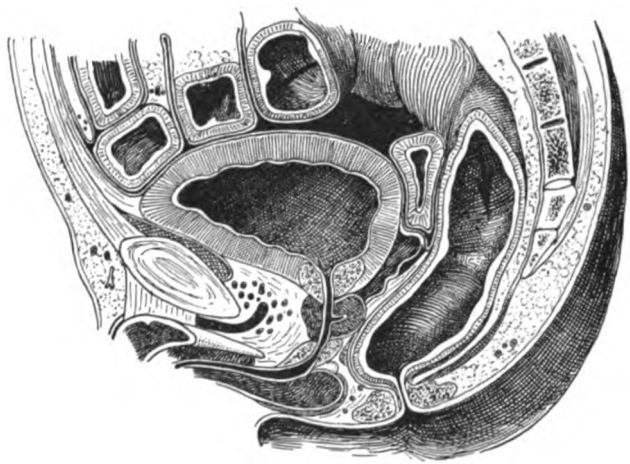


FIG. 189.—MEDIAN SECTION OF RECTUM AND BLADDER, ETC., IN THE MALE. (*From Testut.*)

The relations of the peritoneum and sacrum and coccyx respectively to the rectum are shown; it will be noticed how much of the rectum can be reached after excision of the coccyx.

ship with the pararectal fossæ and their contents, ileum or pelvic colon, below with the coccygei and levatores ani.

In front, in the male, the lower part is in close contact with the prostate gland, the vesiculæ seminales and the vasa deferentia, being separated from these only by the recto-vesical layer of the pelvic fascia. Above this is a triangular area where the base of the bladder and the rectum are in close contact, the recto-vesical layer of the pelvic fascia alone intervening. The boundaries of this triangle are, the reflexion of the peritoneum above, and the vasa deferentia at the sides; above this, again, the rectum is covered on its anterior surface by peritoneum. On the anterior surface the apex of the prostate is 1½ inches from the anus, the base of the prostate 2½ inches, and the reflexion of the peritoneum 3½ inches. In the female the

lower part is in close relationship with the posterior wall of the vagina, whilst above the lower part of the pouch of Douglas separates it from the uterus and upper inch of the vagina.

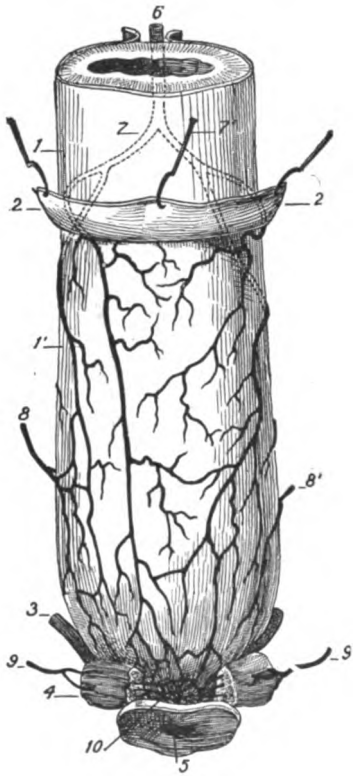


FIG. 190.—VASCULAR SUPPLY OF RECTUM. (*After Testut.*)

1, Peritoneal coat, reflected at 2, from anterior surface of rectum; 3, Levator ani; 4, Sphincter ani; 5, Anal orifice; 6, Superior hæmorrhoidal artery (the termination of the inferior mesenteric); 7 and 7', Division of the superior hæmorrhoidal artery into two main branches about five inches above the anus: these are seen further dividing so as to form four descending trunks in front of and behind the lower part of the rectum; 8 and 8', Anastomosing branches from the middle hæmorrhoidal; 9, Inferior hæmorrhoidal branches from internal pudic; 10, Terminal anastomotic plexus, region of internal piles; 1', Wall of rectum.

2. *The Anal Canal.*—This is that portion of the intestinal canal which pierces the pelvic floor formed here by the levatores ani muscles. These muscles compress it laterally, obliterating its cavity and converting it into a slit-like passage. The upper borders of the muscles may at times be felt during life as distinct ridges.

This portion of the canal passes downwards and backwards to end at the anus, and averages in length one and a half inches.

As the rectum passes through the levatores ani the outer part of its longitudinal muscle fibres unite with these muscles and then pass on outside the internal sphincter to join the skin around the anus.

The circular muscle fibres are much thickened in this portion of the canal to form the internal sphincter, which is united above with the levatores ani and passes downwards for about one inch. The external sphincter forms a muscular cylinder surrounding the lower two-thirds of the anal canal, and has an attachment anteriorly to the central point of the perineum, and posteriorly by means of the recto-coccygeus muscle to the tip of the coccyx; when contracted it is tightly stretched between these two attachments, leaving only a narrow antero-posterior slit between its two halves.

There is a loose layer of areolar tissue forming a submucous coat in which the hæmorrhoidal plexus of veins lies.

Mucous membrane.—In its upper half this shows a number of permanent vertical folds, the columns of Morgagni; they are about half an inch in length, and below are joined together by small semilunar folds, the anal valves, which together form a projecting ridge, the hæmorrhoidal ring. Above each valve is a small depression or pocket, the sinus rectalis. At the level of the valves a white line may be seen running round the anal canal, the "white line" of Hilton; above this line the canal is lined with modified mucous membrane, below with stratified epithelium continuous with the skin.

Relations.—Behind is a mass of connective and muscular tissue, the ano-coccygeal body, between it and the coccyx. In front in the male it lies close behind the bulb of the penis, the triangular ligament and the membranous portion of the urethra. In the female it passes backwards from the vagina, being separated from this by a mass of connective and muscular tissue, the perineal body. Laterally it is clothed by the anal fascia, which separates it from the ischio-rectal fossa.

Vascular supply of the rectum.—The rectum and anal canal are supplied by three vessels, the superior, middle, and inferior hæmorrhoidals. The superior hæmorrhoidal is the continuation of the inferior mesenteric; it passes down in the pelvic meso-colon to reach the upper end of the rectum: here it divides into two branches which run downwards and forwards, embracing the rectum between them; from these pass off five or six secondary branches, which pierce the muscular coat about the middle of the rectum, and then descend as longitudinal branches in the submucous coat, reaching the columns of Morgagni; they pass in these structures as far as the anal valves. Twigs are given off from these throughout their course, which unite to form a hæmorrhoidal plexus (*see* Fig. 190).

The middle hæmorrhoidals are two in number, and come from the anterior division of the internal iliacs; they run down on the side wall of the rectum, and give off branches some of which supply the muscular layers, whilst others pass inwards to the submucous coat, where they form longitudinal branches anastomosing with the other constituents of the hæmorrhoidal plexus.

The inferior hæmorrhoidals arise in the ischio-rectal fossæ from the internal pudic arteries, and are usually two or three in number on each

side. They pass downwards and inwards, and near the wall of the anal canal break up into branches that pierce the sphincters, and form a close network in the submucosa, which supplies the lower part of the anal canal and communicates with the hæmorrhoidal plexus.

Veins.—These form two plexuses, the internal hæmorrhoidal in the submucous and the external hæmorrhoidal in the outer coat; both are devoid of valves. The internal plexus starts as small anal veins beneath the skin of the anus, which pass upwards, and are joined by other veins from the surrounding parts to form larger and often tortuous vessels that run up in the columns of Morgagni, where they often show ampullary enlargements, which are said to be the starting points of hæmorrhoids; passing upwards they communicate with one another, and piercing the muscular coat at the same level as the arteries, join the two branches of the superior hæmorrhoidal veins. The external plexus is united by small branches with the internal plexus; from it arise the inferior hæmorrhoidal veins which pass to the internal pudic vein.

The longitudinal arrangement of the vessels explains the fact that when the rectum is incised in the line of its long axis, the bleeding is comparatively slight, while it is copious if the bowel is divided transversely; and the fact that in the lower part the vessels run in the submucous coat, explains the comparatively slight bleeding that attends the separation of the gut from its lateral connections in the operation of excision.

The **indications for the operative treatment of hæmorrhoids** are as follows:—

1. Continual or often-repeated hæmorrhages and discharge.
2. Persistent prolapse, causing difficulty and pain in walking, sitting, or riding.
3. Repeated attacks of strangulation associated with thrombosis of the contained veins.
4. Severe pain.

It is to be especially noted that no form of radical operation

should be undertaken whilst the hæmorrhoids are inflamed. Neglect of this precaution has led to serious results, and especially to septicæmia and pyæmia. Rest in bed, low diet with aperients, and local antiphlogistic measures should be carried out in such cases until all inflammatory swelling has subsided. The delay is irksome, but the danger of the opposite course can hardly be overrated.

The number of operations that have been introduced for the treatment of hæmorrhoids, and their modifications, is remarkable. A large proportion have fallen into deserved neglect, such, for example, as the injection of carbolic acid and the use of a crushing clamp.

The following methods will be described here :—

Where the piles are limited to small areas.

1. Ligature.
2. Suture around clamps.

Where the piles are diffuse.

3. Whitehead's operation and its modifications.

Preparation of the Patient.—A few days' rest before an operation for piles is carried out is very desirable, although it is not often afforded. During these few days the patient should limit himself to a very simple and moderate diet, should avoid stimulants, and should attend to the action of the bowels. The man who is working hard and living "well" up to the very eve of the operation, and who concludes the preliminary treatment with a "good" dinner, on the plea that it will be some time before he will have another such repast, is not a favourable subject for operation.

The bowels must be well opened by an aperient—preferably castor-oil—administered thirty-six hours before the operation is performed. Just before the surgeon's arrival the rectum should be thoroughly cleared out by a warm water enema, and the nurse should be careful to see that all the fluid injected is returned. A hot bath should be taken on the evening before the operation.

Instruments Required.—*Ligature Operation.*—Clover's crutch;

pile-holding forceps (there are many forms of these forceps —some resemble the volsella, others are constructed on the principle of the pressure forceps, and another series follows the mechanism of artery torsion forceps, and is provided with a sliding catch—it is desirable that the instrument should be self-holding; the most useful variety will be found to be those shaped like sponge forceps, the inner sides of the blades being notched); scissors—sharp and blunt-pointed, straight, and curved on the flat (special forms of hæmorrhoid scissors, such as the well-known scissors or shears introduced by Salmon, are not specially convenient); pressure and artery forceps; silk.

Operations of Suture around a Clamp.—The same instruments, with a narrow-bladed clamp. Smith's was originally used, but these are rather too thick and clumsy in the blade. Makins' small straight intestinal clamp will be found most serviceable. Catgut sutures should be used, and straight needles will be required.

Excision Operation.—The same instruments, with the addition of dissecting forceps, volsella, needles and needle-holders, scalpel, catgut ligatures, sponges in holders. A rectal speculum may be of use.

1. **Operation by Ligature.**—The patient is anæsthetised, Clover's crutch is applied, and the patient is placed in the lithotomy position, the buttocks being brought close to the lower end of the table. The surgeon sits facing the perineum.

The first step consists in dilating the sphincters. Both index fingers are introduced, and the anus is slowly and gradually stretched, or the two thumbs may be introduced and slowly and forcibly separated. The process will require at least two minutes to accomplish, and when complete the anus will be patulous, and the sphincter will have lost its tendency to contract. If a hasty dilatation be effected, the sphincter may relax suddenly, and a laceration of the parts be brought about. The surgeon should maintain a watchful control over the dilating fingers.

The parts are now in a convenient condition for operation.

The piles, which may previously have been entirely withdrawn from view, are now readily exposed, and the whole of the lower part of the rectum can be inspected and explored. The surgeon, after a careful examination of the district, should decide on the number of piles which may require removal.

It is desirable to commence with the hæmorrhoids on the lower or posterior wall of the rectum, since, when the piles on the opposite wall are being dealt with, these are obscured by the blood. Small piles, which are evident enough before the actual operation is commenced, may be lost sight of after some of the main ligatures have been applied. As a preliminary step, it is well to seize each of these smaller excrescences with pressure forceps, which are left in position, as a guide to the site of the pile, until the surgeon finds it convenient to deal with them. These forceps hang loose, and are not in the way. It will usually be found that the piles can be arranged into three bunches, one on either side and one posteriorly ; not more than three bunches should be separated and ligatured, or risk will arise of subsequent stricture formation.

Each pile is seized with the pile-holding forceps, held in the left hand, and is gently drawn away from the anus and towards the middle line. Its base is thus rendered tense, and the line of junction of the skin with the mucous membrane is brought well into view.

By a series of snips with the scissors the surgeon severs all the *lower* attachments of the pile, cutting along the line of junction of the skin and mucous membrane.

By a few light snips, aided with a little pressure from the blunt points of the scissors, the pile is dissected up from the submucous tissue until it is attached only by the healthy mucous membrane above it and by the vessels that are descending to enter it. As the vessels come from above and run just beneath the mucous membrane, and enter the upper part of the hæmorrhoid, this detachment is readily and safely accomplished, and the bleeding is very trivial.

The detachment should be sufficiently extensive to form a deep groove.

The forceps are now handed to an attendant, who maintains the traction upon the pile, while the surgeon places a silk ligature round its pedicle, which he at once proceeds to tie as tightly as possible.

The ligature should not be too thick, and it should not be applied with such violence as to cut the pedicle of the pile entirely through. Before tightening the knot, the ligature should be so manipulated as to include the highest part of the mucous membrane left attached to the pile.

There are three points to be specially attended to in applying the ligatures. The groove in which each lies must be made within the margin of the external sphincter, so that the ligature includes no part of the muscle. Secondly, there must be no risk of the ligature slipping after the stump has been returned, for most troublesome hæmorrhage may then result. The tighter it is tied the better, and a third knot should be made for security. The scissors should not be applied too closely to the ligatures. Thirdly, as small a portion of the mucous membrane as possible should be included in the ligature, for if the bases are left large and broad, when tied the mucous membrane will be drawn together, and great narrowing of the rectum be caused.

The operation is completed by cutting the ligatures off, and by snipping away about two-thirds of the strangulated hæmorrhoidal tissues which project beyond the knot. The parts are lightly dried and returned within the sphincter.

A soft pad of moistened gauze, over which is a square pad of absorbent wool, is then secured in place by a firm T-bandage. It is customary to insert within the rectum a suppository containing a quarter to half a grain of morphia before applying the dressing.

When the hæmorrhoids form a complete circle within the anus, the most prominent portions must be isolated by means of incisions made through the mucous membrane; and when

the pile mass has thus been divided into segments, each part is ligatured separately.

This method of employing the ligature is that introduced by Salmon at St. Mark's Hospital.

Some surgeons prefer that the patient should lie during the operation upon one side, with the knees well drawn up.

The plan of drawing forward a pile and of transfixing its pedicle with a needle in a handle carrying a ligature, and of then securing the pile in two parts, is to be condemned. A great deal more tissue is taken up than is necessary, the vein in the excrescence may be transfixed by the needle, bleeding may follow, and risk of septic infection is incurred.

This operation can be easily and quickly performed, but has the following objections :—

i. Although theoretically there should be little or no hæmorrhage, yet this is often found to be quite considerable, there being small arterial twigs at the lower part of the hæmorrhoid which are divided, and although these are so small that no danger need be apprehended of subsequent hæmorrhage taking place from them, yet in the course of the operation more blood may be lost than a weakly or anæmic patient may be well able to stand.

ii. In ligaturing the posterior hæmorrhoids it is often found that the ligature in part slips, a raw oval surface being left, to cover which the mucous membrane has to be sewn to the skin below.

iii. The ligatures, being of silk, have to slough away.

iv. The pain following the operation is often severe.

2. **Suture round Clamps.**—There are two varieties of this operation, which differ only in the method of fixing the sutures, that of Mitchell with modifications being the more suitable.

The patient being placed in the lithotomy position, the anus is dilated as above ; each pile is then seized and clamped in the long axis of the gut, Makins' small straight intestinal clamp being the most satisfactory. The amount clamped must be adjusted so that the whole pile is within the clamp, but that sufficient

mucous membrane to cause narrowing of the lumen is not included. A straight needle threaded with catgut is then passed through the upper end of the hæmorrhoid, so as to include the main vessel, and tied. The needle is then passed through the hanging pile, round the clamp, and through the base, and so to the other end of the clamped pile. It is finally brought through the base, the threaded end being left long and projecting through the far side of the base. The pile is then cut off just distally to the clamp. The catch in the handle of the clamp being then undone, this is gently slipped off the stump of the pile from beneath the suture; by pulling on the needle the whole length of the continuous suture is tightened up, and the edges of the mucous membrane brought into apposition. There is no subsequent bleeding, the main vessel being tied securely in the first knot, whilst the continuous suture firmly secures the cut edge. The suture is firmly fixed by tying the two ends together.

In Mitchell's original operation (*Brit. Med. Journ.*, February, 1903) a Smith's clamp was used, and the pile was cut away before the suturing was commenced, but after tying the first knot and ligature of the main artery. With a Makins intestinal clamp, one has a narrow-bladed instrument, which is readily withdrawn, and round which the suture is easily passed. It is, however, more likely to slip from the stump before suturing is commenced; this difficulty is readily overcome by removing the pile after the sutures have been passed, as advised above.

Modifications of this have been performed whereby the clamps are not applied until after the lower part of the hæmorrhoid, including the redundant skin, has been severed from the sphincter.

This is undoubtedly one of the best operations for hæmorrhoids. It is easily and quickly performed; there is absolutely no hæmorrhage throughout the whole course of the operation. By a careful adjustment of the clamp, there is no fear of including too much mucous membrane, and hence risk of stricture. Owing to the accurate apposition obtained between the edges

of the mucous membrane, primary union is secured, and convalescence is rapid, and hæmorrhage, reactionary and secondary, is prevented. The sutures, being of catgut, are absorbed, and there is no strangulated portion of tissue which has to slough off, as is the case in removal after ligature.

In the older method of performing this operation (Jones, *Prov. Med. Journ.*, 1893) the hæmorrhoids were clamped in a Smith clamp, with about an eighth of an inch projecting after the rest of the pile was cut off. A piece of catgut, threaded with a needle at each end, was passed through the upper end of the pedicle distally to the clamp, and the two ends were tied. The needles were again passed in opposite directions, through the pedicle a little lower down, and tied, and so on to the lower end of the pedicle; by this means it was sutured continuously, but each segment was made independent of the next by the cross and knot. This operation shows no advantage over the last, and the powerful clamp is liable to cause sloughing of the distal portion of the pedicle.

3. **The Operation by Excision.**—Of the various methods of treating piles by excision which have been from time to time employed, the most precise, and probably the most successful, is that introduced by Mr. Walter Whitehead (*Brit. Med. Journ.*, February, 1882, and February, 1887). The operation is carried out on sound surgical principles, and has been attended with considerable success. It is indicated for those cases in which the hæmorrhoids are diffuse, the whole or the greater part of the hæmorrhoidal ring being affected. It should be limited to these cases, or to cases where recurrence has occurred after the simpler operations. It is more extensive and severe, and more difficult to keep aseptic, and is accompanied by more severe hæmorrhage. Care must be taken to obtain good apposition between the mucous membrane and skin, otherwise primary union does not occur, and there is considerable liability of a stricture resulting. In some cases the mucous membrane after two or three days may become soft and swollen, and is then very liable to tear through the sutures and retract away from

the skin; severe hæmorrhage has thus sometimes occurred, or stricture resulted. The more carefully the suturing is done, the rarer are these accidents.

The patient is secured in the lithotomy position by Clover's crutch, and the sphincters are fully dilated. "By the use of scissors and dissecting forceps the mucous membrane is divided at its junction with the skin round the entire circumference of the bowel, every irregularity of the skin being carefully followed. The external and the commencement of the internal sphincters are then exposed by a rapid dissection, and the mucous membrane and attached hæmorrhoids, thus separated from the submucous bed on which they rested, are pulled bodily down, any undivided points of resistance being nipped across, and the hæmorrhoids brought below the margin of the skin.

"The mucous membrane above the hæmorrhoids is now divided transversely in successive stages, and the free margin of the severed membrane above is attached as soon as divided to the free margin of the skin below by a suitable number of sutures" (*Brit. Med. Journ.*, Feb. 26th, 1887, page 449).

In this way the complete ring of pile-bearing mucous membrane is removed. All bleeding vessels encountered throughout the operation are treated by torsion. As a rule, only one or two need this treatment.

The separation of the mucous membrane is accomplished with the fingers and the end of a pair of blunt-pointed scissors.

The sutures employed are of catgut, and are allowed to become absorbed.

In the paper from which the above quotation is made Mr. Whitehead reports 300 consecutive cases of hæmorrhoids which he has treated by excision alone, without a death, without a single case of secondary hæmorrhage, and without any instance of complication or relapse.

Details of the Operation by Excision (Fig. 191).—The patient having been secured in the lithotomy position by means of Clover's crutch, the perineum is shaved if necessary. The sphincters are very thoroughly dilated, and the piles are made to protrude com-

pletely. A temporary plug of gauze should be inserted into the rectum to prevent any fæcal material from descending during the course of the operation. If a long ligature be attached to it, it is easily withdrawn later. As blood soon obscures the view, it is best to commence the operation at the lowest point of the anal margin, then to proceed to the sides, and finally to the upper margin. By means of a short, sharp scalpel the mucous membrane is divided at its exact point of junction with the skin around the entire circumference of the anus. All the inequalities

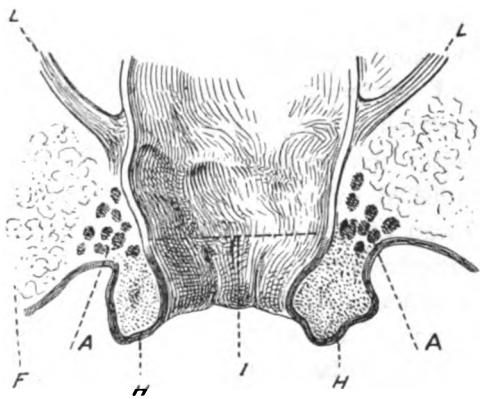


FIG. 191.—TRANSVERSE VERTICAL SECTION THROUGH RECTUM, THE SITE OF MARGINAL HÆMORRHOIDS (HH).

LL, Levator ani; AA, Sphincter ani externus; F, Fat in ischio-rectal fossa. The dotted line I shows the level at which the mucous membrane should be divided in Whitehead's operation; the point at which the dotted line running up from AA crosses the perianal skin indicates the line at which the latter should be divided.

of the surface are followed, and in places where the skin is distinctly redundant a variable amount of integument is included in the part to be removed—*i.e.* in such places the knife travels a little away from the mucous membrane. Two assistants are present, who stand one on either side of the operator. As soon as the above incision is completed, pressure forceps are attached to the margins of the cut skin at four equidistant parts, which may be referred to as north, south, east, and west of the anal orifice. Pressure forceps are also attached to corresponding doints on the margin of the divided mucous membrane. By

drawing in opposite directions any two companion forceps, the separation of the mucous membrane at that point is much assisted.

The circular incision is gradually deepened, most conveniently with blunt-pointed straight scissors aided by forceps. The separation of skin and mucous membrane is carried out until the external sphincter is recognised. Its most external fibres are indistinct, but there is very little difficulty in soon demonstrating its form as a circular band of muscle, which is carefully preserved. As soon as the external sphincter is cleared, the separation of the mucous membrane becomes easy.

The surgeon must remember that the operation consists in the excision of an unbroken circle of mucous membrane and submucous tissue containing veins, and of nothing else. The separation of this ring or tube of mucous membrane is readily accomplished by the blunt point of the scissors, aided by the finger, and at every step assisted by traction upon the forceps, which are fixed to the cut edge of the mucous membrane. To aid such traction, additional forceps (in excess of the four already in use) may be attached to the mucous membrane where needed. The tube of mucous membrane must be well and evenly isolated all round, and the separation must be continued up to a point at least half an inch above the intended line of section. The internal sphincter is in no way disturbed. Up to this point the bleeding is trifling, and any vessels which give trouble are seized with pressure forceps and dealt with by torsion.

The surgeon now proceeds to cut through the isolated tube of mucous membrane, which includes all the piles and, indeed, all the pile-bearing district. He introduces the fore-finger of the left hand into the mucous tube, and divides it in a circular line, which is at right angles to the long axis of the rectum. He makes the division bit by bit, while an assistant draws upon the forceps which have been fixed to the anal edge of the mucous membrane. As each vessel is divided, it is secured by pressure forceps. A little experience will teach the operator where the

vessels lie, so that their division is not made unexpectedly. In due course the involved mucous membrane (with the original forceps still attached) is entirely removed as an unbroken ring or tube. There then remains the divided line of skin with the original forceps still attached, and the divided line of mucous membrane, to which some six to ten forceps, securing vessels, will be attached.

The sutures are now ready to be applied. The best suture material is fine chromicised catgut used absolutely dry. The suture is of good length, and is carried in a curved needle. The surgeon passes the needle through the edge of the divided skin, and then, taking up in his left hand one of the forceps affixed to the mucous membrane (and also grasping a cut vessel), he passes the needle through the mucous membrane in such a way as to take up the vessel in question. He then removes the forceps and ties the ligature in a firm surgeon's knot. Thus the cut edges of the skin and mucous membrane are brought together, and the divided vessel in the latter membrane is secured by being, as it were, underpinned by the single suture. In this way the wound is closed all round. From ten to twenty sutures will be required. No vessel needs to be ligatured, nor even to be twisted. The suture controls each one quite perfectly. Additional sutures are applied where required. The suture involves only the skin, the mucous membrane, and the vessel in the submucous tissue. The sphincter is excluded entirely from it.*

The wound, after union, looks irregular and untidy, but it soon assumes a regular outline. The parts are dried, are dusted with iodoform if considered desirable, and are well and firmly supported by a dry pad of wool held in place by a stout T-bandage. This pad need not be disturbed for forty-eight

* It often happens that the whole ring of mucous membrane is not involved in the hæmorrhoids, and in such cases a "modified Whitehead" may be done. The attachments of the healthy mucous membrane to the anal skin are left, the intervening pile-areas being excised. Suturing is rather awkward by this method, but the risk of retraction is rendered less.

hours. The catgut sutures are not touched. They are allowed to work out in due course. We have performed this operation in some hundreds of cases without a death, without any after-bleeding, and without any deep suppuration.

The pain after the operation is slight. In a few instances we have met with a trifling linear contraction at the exact skin margin of the anus. This has never given any real trouble, and has always yielded to stretching with the fingers or to the passing of a bougie daily for a few days.

A modification of this operation has been introduced by Vernon (*Brit. Med. Journ.*, 1907). A hollow bullet-shaped metal cone, held in a temporary handle, is passed into the rectum. This being pulled down the anus is prolapsed, and two metal pins are passed through the skin externally to the sphincter, through the mucous membrane, the holes in the cone, and again through the anal wall on the opposite side. A piece of rubber tubing is fixed on one of the pins, tightly wound round the prolapsed area, and fixed. The prolapsed pile-bearing area superficial to the sphincter is then excised, and the mucous membrane sutured to the skin by a continuous catgut suture. Mr. Vernon claims for his method that it is neat and comparatively free from bleeding, but after trial we think it has several disadvantages, and is most unlikely to come into general use.

The Clamp and Cautery.—This method has fallen into discredit, and is now but rarely used. The anus being dilated, the hæmorrhoid was drawn down and fixed in the clamp, which was tightly screwed up, the pile was then cut off, and the stump seared with the cautery. The clamp was removed and the pedicles were replaced.

Comment.—Out of the operations above described it would be impossible to select one as the best if it were attempted to found the selection upon the writings of those surgeons who have more especially concerned themselves with this branch of surgery. Each operation has its own vigorous advocate, and in the hands of these special pleaders such excellent results are obtained as to make a safe criticism difficult.

The operation of ligature is easily and quickly performed, it is attended with much less hæmorrhage than Whitehead's operation, it appears to be the safest as regards such complications as subsequent contraction of the anal margin.

It is the operation recommended by such authorities as Sir C. Ball, and the usual one performed at St. Mark's Hospital for Diseases of the Rectum. On the other hand, the principle of causing death of tissue by the constriction of a ligature has gone out of surgical use in every other region of the body, and in the case of hæmorrhoids is denounced by some as bad, since a raw surface is left which has to granulate up. However, in the case of any form of suture operation primary union cannot be guaranteed; in fact, our experience has been that perfect union is rarely if ever obtained along the whole line of suture.

The amount of pain experienced after the operation by ligature is, as a rule, more than after the suture-methods, but it can be controlled by morphia, and in many cases is only slight. No method is entirely free from risk of contraction. Suture over a clamp is wholly unsuited to cases where the piles have broad bases or occupy the whole circumference. Whitehead's operation is tedious, is attended with considerable bleeding, and if not performed carefully may lead to disastrous results. For the average case ligature is the safest. At one large hospital the clamp and cautery are still employed as a routine.

After-treatment.—After the stumps left by the operation have been returned, the parts should be well dried.

A pad of soft gauze may be placed over the anus, and be fixed in position by a T-bandage. Or in the place of the pad and bandage, a "sanitary towel" may be worn.

The pad or the towel supports the part during coughing or vomiting, absorbs any blood which may escape from the anus, keeps the buttocks apart, and prevents the involuntary straining which is common after these operations.

The pad or the towel may be discarded in a few days.

A morphia suppository inserted at the time of the operation

is of service, and is very usually employed. The suppository may contain from a quarter to half a grain of the drug. A little opium at night-time is, moreover, always desirable *for the first few nights*. The patient is occasionally troubled by spasm —apparently of the levatores ani—which may be relieved by opium, and by opium only.

The patient should retain strictly the recumbent position. The anus should be washed night and morning, and dried. In some cases the patient has derived most comfort from a wet pad soaked with warm boric lotion, and pressed firmly against the anus.

Whatever method of suturing has been adopted it is advisable to prevent fæces passing over the wound for two or three days at least, and with the very light diet taken during this time there is no occasion for an early aperient.

In cases of ligature or Whitehead's operation, it is well that the bowels should not be opened until the morning of the fourth or fifth day. In these cases a tube should be inserted into the rectum after operation to allow of the free escape of flatus. A dose of castor-oil or of any other suitable aperient may be given, and just before the bowels act it is well to inject into the rectum some two ounces of warm olive oil. This injection is most conveniently given by a glass syringe. Patients usually dread the first action of the bowels, and the use of a bed-pan gives substantial grounds for that dread. In private practice the following substitute for the uncomfortable bed-pan may be employed. The patient lies upon the left side with the knees drawn up towards the chin and the buttocks projecting beyond the edge of the bed. The buttocks are oiled, and beneath them is placed a very large—and, indeed, voluminous—pad of cotton wool. Beneath this substantial pad is a mackintosh sheet, which entirely protects the bed. The motion is passed into the cotton-wool receptacle, and the whole is removed in the mackintosh sheet. If there are scybalous masses in the rectum—as is not unusual when much opium on the one hand and much milk on the other have been taken—they must

be got rid of by enemata. We are of opinion that the less opium given and the less milk drunk after a pile operation the better. The ligatures usually come away about the sixth or seventh day, and at the same time the sloughs left by a crushing or cautery operation may be expected to be expelled.

After the fifth or sixth day the bowels should be made to act every day, an aperient being administered as often as required.

Until the bowels act, the patient should be limited to a slop diet. Stimulants should be avoided, except in the case of the aged or feeble.

After the bowels have acted, the patient may commence with fish, and later with meat. A liberal allowance of fruit and of suitable vegetables will be found of service. In the matter of diet, the patient's own inclination and appetite are usually surer guides than certain arbitrary rules which are founded upon the tastes and powers of an abstract stomach. It is to be remembered that a "slop diet" promotes flatulence. We have already commented upon the too liberal use of milk after these operations.

It is impossible to indicate precisely the duration of the after-treatment. It will depend largely upon the extent of the operation and upon the disposition of the patient. In a case of average severity the patient will probably be moved on to a sofa on the tenth day, and will be up between the fourteenth and the eighteenth day. It is most undesirable to allow the patient to get up too soon. No one single factor in the management of the case is more likely to protract the recovery than is a too early "getting-up." Time is always a most important element in the management of operations for piles.

It is well to remember that on the second or third day after the operation some œdema of the anus is usually met with, and that this is apt to give the patient unnecessary alarm, and to induce a belief that the piles have "returned" in full force.

Undue irritation about the anus may usually be relieved by calomel ointment (calomel, ʒi ; vaseline, ℥i).

The chief complications which may occur during the after-treatment are retention of urine, hæmorrhage, tedious ulceration, and contraction of the anus. The surgeon should make sure that healing has been sound before the patient passes out of his view. The patient should be warned against constipation.

CHAPTER XXXII

OPERATIVE TREATMENT OF ANAL FISTULA, FISSURE AND ULCER

The Varieties of Fistula in Ano are conveniently divided as follows: (1) Complete, in which there are distinct external and internal openings. (2) Blind external, in which an external opening alone exists. In not a few of these cases there is an internal opening, but from its being very small or situated in an unexpected place, it is overlooked. (3) Blind internal, in which the internal opening alone exists, the skin being sound.

Both the openings are usually situated within an inch of the anus, and most commonly within half an inch of that part. The external opening may be very small, may be obscured by a fold of the skin, and may only be detected by squeezing pus out of it. The tract of the sinus can often be made out as a hard cord running in the wall of the bowel.

The site of the internal opening may sometimes be detected as a slight depression or papilla, or it may be demonstrated by the probe. In any case of doubt the finger may be dried and introduced into the bowel, and retained there while a little iodine is injected into the sinus. A brown stain upon the finger would prove that an internal opening existed, although it may not have been actually demonstrated.

The examination of a fistula should be very carefully conducted; small pliable probes should be used, and in any case of difficulty a speculum should be employed. It must never be forgotten that the connection between the mucous and muscular coats of the bowel is comparatively lax, and that a large steel director, roughly used, will pass with great readiness through the submucous tissue, and will give rise to conceptions

of burrowing sinuses which exist only as results of the surgeon's bungling.

To Percival Pott is due the credit of introducing the present method of operating. It was a common practice in his time to excise the entire sinus. It is still common to hear the uneducated classes speak of having a fistula "cut out." Pott demonstrated the possibility of curing fistula by simple incision.

Operation.—The patient is prepared in the same manner as is described in the previous chapter (page 707).

He is placed in lithotomy position, and is secured there by a Clover's crutch. It is assumed that an external opening exists. A Brodie's probe-pointed fistula director is introduced into the fistula, and is passed into the bowel through the internal opening. Not the very least force must be employed. The internal opening might have been already examined, and the passing of the probe may be carried out while a speculum keeps the inner opening in view. If the director does not easily pass, a flexible or specially bent probe may be introduced. If the probe is found to present under the thinned mucous membrane in a case in which no internal opening exists, the point of the director should be thrust through the mucous membrane at the thinnest spot. In every case, when possible, the probe should be passed while the left fore-finger occupies the rectum and acts as a guide.

In a simple case in which the inner orifice is low down, the point of the director may be engaged upon the tip of the left fore-finger (lying in the rectum), and may be cautiously brought outside the anus. Nothing then remains but to slit up the fistula with a sharp-pointed curved bistoury.

When the inner opening is high up, persistent attempts to bring the point of the director out of the anus may lead to undue laceration of the part.

In such a case, the sphincter having been very fully dilated, the interior of the bowel must be well exposed by means of a suitable speculum and well illuminated by means of a small

electric lamp. The division is then made while the parts are in full view of the operator.

After the division of the fistula comes the most delicate part of the operation—the search for secondary fistulæ, for burrowing tracts, and for diverticula from the primary sinus. For this examination again are needed a well-stretched sphincter, a speculum, rapid sponging, a good light, and suitable probes.

The finger should search for any tracts of indurated tissue, and the surgeon should note if the escape of a bead of pus follows pressure in any direction.

Any secondary sinuses must be treated as their condition indicates. Those which burrow beneath the mucous membrane should be slit up for their entire length. No object is gained by sparing the mucous membrane, and hesitating and incomplete incisions will always be regretted. In no case, however, must the internal sphincter be completely divided; such treatment is almost sure to lead to permanent incontinence of fæces. Secondary sinuses, which pass away from the rectum, must be liberally slit up. When this involves too great a division of the soft parts, they may be freely opened into the original wound, may be dilated with dressing forceps and the finger, and well scraped with a sharp spoon or seared with the actual cautery, and then well stuffed with gauze.

All the pulpy granulation tissue which is met with about fistulæ should in every case be scraped away. The surgeon should endeavour to leave as clean and fresh a wound as possible.

In the division of the fistula the anal margin is of necessity in every case divided, and in order that the section of the muscle fibres should be as direct as possible, the knife should always cut its way into the bowel at right angles to the anal margin.

If any piles exist, they should be removed at the time of the operation, and all ill-nourished flaps and tags of inflamed and undermined skin should be cut away.

In old-standing cases, when the edges of the fistula are very indurated and callous, Salmon's "back cut" may be carried out. After the usual division of the fistula, a linear cut is made

through the dense tissue of the fistula, and through that portion of the sphincter muscle which is outside the tract of the fistula.

In certain *blind external fistulæ* the sinus extends as far as the levator ani, and then turns abruptly away from the rectum, instead of burrowing down between the sphincters. In such cases division of the sphincter would effect no good, but the sinus, on the other hand, should be very freely laid open from the external orifice, should be scraped out, and then dressed from the bottom.

In *blind internal fistulæ* the site of the threatened external opening may be indicated by a little redness of the skin, or by induration or fluctuation, or the tract of the sinus may be marked by an indurated cord.

In any such case a knife thrust through the skin at the point indicated would open the sinus, and allow of a director being introduced, and of the operation being concluded in the usual way.

Failing such indication, a speculum should be introduced, and the inner aperture sought for. When it is found, the end of a probe bent very much upon itself is introduced, and the point is made to project towards the skin. Upon this projecting point the first incision is made.

In cases of *horseshoe fistula*, in which an external opening on either side of the anus communicates with a single internal opening, usually at the back of the bowel, it is undesirable to cut through the sphincter on both sides. If this be done, much loss of power will result. It is better to divide the sphincter on one side, and to dilate the other side of the fistula to its utmost from the wound thus made, and to scrape it well. The cavity thus produced can then be dressed from the bottom. If, later, it should become necessary to cut through the anal margin upon the opposite side, much less loss of power results than is the case when the sphincter is divided in two places at one sitting.

When the *sinus extends far up along the bowel*, it should still be the practice to slit up the undermined tissues. When, how-

ever, the thickness of the structures to be divided renders it probable that much bleeding may ensue, the knife can be carried up as far as appears desirable, and the highest part of the sinus may then be treated by means of dilatation and scraping or by the actual cautery.

When *multiple fistulæ* exist, burrowing in various directions, it is well to adhere to the rule of dividing the sphincter in one place only. The sinuses are slit up in all directions, granulation tissue is scraped away, undermined skin is excised, fistulæ which cannot be cut open are dilated, scraped, and dressed from the bottom. In these cases one or even more subsequent operations may be called for. The rectum should always, in such cases, be examined for stricture or extensive ulceration, as some such underlying condition is often the cause of multiple fistulæ.

After-treatment.—It may almost be said that the after-treatment of the case is of more importance than the operation. When all bleeding has been checked, the parts should be well dried, and a folded piece of lint, or, better still, a strip of iodoform gauze, should then be lightly packed into the incision. A large pad of wool is applied over the part to maintain pressure, and to overcome any inclination to strain, and is fixed in place by a T-bandage. This outer dressing can be replaced later by a sanitary towel only. A morphia suppository may be employed. In forty-eight hours the first dressing should be removed, the part well washed, and re-dressed. The dressing consists of a folded piece of lint or of gauze firmly packed in the wound. It may be moistened with oil, or with calomel or other ointment, or be dusted with boric acid. The whole of the gap or gaps made by the operation must be well and carefully stuffed from the bottom.

The part should be dressed night and morning, and after each action of the bowels. Scrupulous cleanliness must be insisted upon. A hip-bath may be taken daily after the action of the bowels.

The bowels should at first be kept confined, but should be

opened by means of a dose of castor-oil on the third or fourth day. It must be seen that they act regularly after this.

The discharge will be free for about the first ten days.

The dressing may need to be changed from time to time, and the lint may be soaked with sulphate of zinc lotion, with a nitrate of silver solution, with the compound tincture of benzoin, with weak iodine, or with such other drug as the surgeon employs in like cases.

The parts may be over-dressed, and the skin around be kept in a condition of irritable inflammation. Every care must be taken that the skin does not heal over prematurely, and a constant watch must be kept for burrowing sinuses and for undermining of the skin. "Pockets" for pus soon form, and good drainage should be maintained throughout.

The diet should be simple, but not meagre. Every means should be taken to improve the general health.

The operation will probably involve, in an ordinary case, confinement in bed for some fourteen days, followed by another week or so in the house. In a complex case, with many deep sinuses, the after-treatment may extend over many months. Rest is all-important, and the healing process is very distinctly retarded by too early movement. Change of air will often do more for an indolent sinus than will the most elaborate dressing. Some loss of power over the sphincter will be noticed for a little while. It is generally regained within three weeks. A permanent weakening of the anus may result, but it is very uncommon.

Other Methods of Operating.—Some surgeons employ specially-constructed scissors for dividing the fistula, but no particular advantage can be claimed for them.

The division of the tissues about a fistula by the thermo-cautery, the galvanic *écraseur*, or the wire *écraseur*, has nothing to recommend it.

The treatment of fistula by the elastic ligature was at one time extensively employed. It is attended by no hæmorrhage, and was recommended for cases of deeply-extending fistulæ. The ligature is made of a solid cylindrical rubber cord, one-

tenth of an inch in diameter. One end of the loop is introduced along the sinus by means of a special director, while the other end hangs in the rectum. A pewter ring is then threaded over the two ends, and as the ligature is drawn tight the ring is made to clamp the two cords by compressing it with necrosis forceps. The ligature is allowed to cut its own way out. This it will effect, on an average, in six days. There is little to recommend the measure, which is attended by no little pain.

In individuals suffering from hæmophilia, it is probable that the risks of bleeding would be as great after the use of the ligature as after the use of the knife.

Nor has it been shown that the after-treatment is shortened by this method.

FISSURE AND ULCER

The condition commonly known as fissure *in ano* is practically always an ulcer, which, owing to the contraction of the sphincter, has been narrowed from side to side to resemble a fissure running in the long axis of the gut; its nature can be determined by dilating the sphincter.

In a large number of cases it is caused by tearing down one of the anal valves, an ulcer being left above, the œdematous valve persisting and forming the so-called "sentinel pile."

Indications for Operation.

1. Where palliative methods of treatment have failed.
2. Where the pain is severe and long continued, or there have been many relapses.

Operation.—These cases are often treated in out-patient departments, but such a practice is to be avoided. The patient should be in bed for a few days before operation, and the same preparations made as for other rectal operations. The incontinence which often results, and lasts for a day or two, can also only be dealt with if the patient is in bed.

The patient is anæsthetised and placed in the lithotomy position. The anus being then well dilated, the ulcer is brought well into view; its base and the superficial fibres

of the external sphincter are divided in the long axis of the gut, care being taken that the incision is made deepest at the lower border of the ulcer, so that a ridge is not formed which the fæces would tear (Curling).

Other operations, such as cutting from within outwards, simple dilatation of the sphincter, and excision with suture, have been recommended, but the above operation is so simple and so uniformly satisfactory that these others are unnecessary.

CHAPTER XXXIII

OPERATIVE TREATMENT OF PROLAPSE

It is usual to divide prolapse of the rectum into two classes. The *partial* form is that in which the mucous membrane is alone extruded, and in which the muscular coat remains unchanged in position. The *complete* form is that in which all the coats of the rectum, including the peritoneal covering, are extruded, and are involved in the prolapse. The partial prolapse is usually of slight extent, and may measure but an inch or two in length. In the complete variety the protrusion is more extensive, and may measure as much as six inches, or even more.

The methods of treating prolapse by operation are numerous. Many of these have fallen entirely into disuse, while some appear to have commended themselves to few besides the actual inventors.

It is needless to describe the treatment by the injection of various fluids into the ischio-rectal fossa. Removal of the mass by the galvanic or cold wire *écraseur* has not proved to be an encouraging procedure ; and the same may be said of the " radical cure " by means of elastic ligatures, aided by the liberal application of chloride of zinc.

Indications for Operation.

1. Alterations in the mucous membrane, such as ulceration, causing hæmorrhage.
2. A large prolapse which has existed for a long time.
3. In children only those cases which have resisted all other forms of treatment, and in which the bowel is more or less continuously down.
4. Incontinence of fæces.

1. **Treatment by Caustics or the Cautery.**—The bowels having been evacuated according to the method advised in preparing a patient for operation for hæmorrhoids (page 707), the subject is placed in the lithotomy position, and the thighs are secured by a Clover's crutch.

With a little manipulation the prolapse can usually be made to protrude, or it may be drawn down with forceps. It is then well dried with cotton wool, and is ready for the application of the caustic or cautery.

The usual caustic employed is strong nitric acid. This is painted over the whole of the exposed surface, care being taken that none of the acid touches the verge of the anus or the skin. The part is then well oiled and returned, and the rectum is lightly stuffed with gauze soaked in oil. Outside the anus a supporting pad of wool is fixed firmly in position by a T-bandage.

If the actual cautery be employed, the iron, heated to a dull-red heat, is applied to the whole length of the prolapse, in the form of a series of lines in the long axis of the bowel. Four of such linear burns at equal distances from one another will suffice. The width of each line will be about one-fourth of an inch. The burn should be sufficiently deep to sear, but not actually destroy, the mucous membrane.

The operation should be performed quickly, and the prolapse at once returned, before any swelling takes place.

To carry out this measure, it is essential that the prolapse should be extruded.

A morphia suppository is introduced into the bowel, and after it a slight plug of well-oiled gauze. The anal region is then well supported by a substantial pad of wool under a firm T-bandage.

The *after-treatment* involves lying in bed for two or three weeks. The plug of gauze is removed from the rectum in twenty-four hours. Opium will be needed to overcome the disposition to strain which is often complained of. Flatus is got rid of by passing a rectal tube two or three times a day as required. The bowels should be opened with castor-oil on the

fourth day. An oil enema may assist the process. The motion should be passed while the patient lies upon the side, as described in the section on the excision of piles (page 720). There must be no straining, and no bed-pan must be employed. After the fourth day the bowels should be made to act daily.

2. **Treatment by Excision.**—This operation may be illustrated by two actual cases—one of partial and the other of complete prolapse, both treated by excision.

An account of this operation, with three illustrative cases, has been given in a paper published by one of us (F. T.) in the *Lancet* for March 1st, 1890. Cases of excision of the prolapsed bowel have been reported by Mr. S. Partridge, Mr. Raye, and others. (See *Indian Annals of Medical Science*, No. xxvii., page 237; and *Lancet*, July 10th, 1886.)

Case of Partial Prolapse.—Man aged thirty-seven; length of prolapse five inches. The patient was prepared as for the operation for piles, was placed in lithotomy position, and secured by Clover's crutch. The buttocks were well raised, partly for the purpose of bringing the region in more convenient position for operation, and partly that the coils of small intestine might be to some extent withdrawn from the pelvic floor in the event of there being any protrusion of the peritoneum. After a thorough dilatation of the sphincter, the first step of the operation consisted in demonstrating the full extent of the prolapse. The mucous membrane within the lumen of the prolapse was seized, at some height above the aperture in the bowel, with tongue forceps, and pulled down. Three pairs of such forceps were employed, and were applied at different points on the rectal wall; and when it was evident that the whole of the relaxed mucous membrane was entirely drawn down, the forceps were allowed to remain attached. They served to indicate the real apex of the protrusion, and to allow a hold to be taken of the part, while their weight prevented any great recession of the everted mucous membrane.

A circular cut was now made around the base of the prolapse, at the exact spot where the skin joined the mucous membrane.

The incision involved the mucous membrane only. This mucous membrane was next dissected off, the whole of it being turned down like a cuff.

It was dissected up with scissors and forceps only. When the separation was complete, the prolapse had an hour-glass shape, the waist of the hour-glass corresponding to the site of the apex of the protrusion. Nothing but a raw surface was visible, and the prolapse was, of course, doubled in length. The bleeding was quite insignificant. The object of this dissection was to demonstrate clearly the nature of the tissues forming the prolapse, which were about to be excised. Both sphincters could be defined. The left fore-finger was now introduced into the lumen of the prolapse, and it was ascertained that the protrusion was composed of mucous membrane only. The layer of mucous membrane—the inner layer—was next divided at the level of the anus with scissors. As each inch or so was divided, the cut margin was seized with pressure forceps. This allowed of the immediate arrest of all bleeding, and also prevented the mucous membrane from being withdrawn into the rectum. The prolapse was in this way completely excised, and some six or eight pressure forceps were left attached to the cut mucous membrane of the rectum. The forceps were removed, bleeding points were ligatured, and the mucous membrane was then attached to the skin at the margin of the anus with sutures of silkworm gut. Eight vessels were ligatured, and fifteen sutures were applied.

The part was dressed with wool dusted with iodoform. The bowels were opened on the fifth day; the sutures were removed on the tenth. At the end of four weeks the parts were sound, and the function of the anus was entirely restored.

Case of Complete Prolapse.—Man aged thirty-six; prolapse measured five inches in length. Its circumference at the base was no less than ten and a half inches. The operation was commenced in the manner already described. The mucous membrane forming the outer wall of the prolapse was separated all round, as in the above case, the knife traversing the skin

close to its line of junction with the mucous membrane. The protrusion, quite bared of mucous membrane, was now exposed.

It felt hard and firm, except at its anterior part, close to the anus. Here there was evidence of a protrusion of peritoneum. The wall of the cone was at this point flaccid, and compared very markedly with the firm wall presented by the rest of the prolapse. The buttocks had been well raised, to hinder the protrusion of any coils of small intestine, and no evidence of such a hernia existed. The prolapse at the level of the anus was then cut across—*i.e.* at the very base of the cone. The anterior wall was divided first, and the peritoneal cavity opened ; the opening was at once plugged with a sponge. The rest of the prolapse was then severed rapidly with scissors in the manner already described. The peritoneal wound was closed by seven points of the finest catgut. The divided end of the bowel was then attached to the margin of the anus, all hæmorrhage having been arrested. The sutures involved the skin, the whole thickness of the wall of the rectum, and as much as possible of the subcutaneous structures about the anus. Silkworm gut was employed. The bowels were opened on the seventh day ; no sutures were removed until the thirteenth day. The patient got up on the nineteenth day. The wound healed soundly, without a drop of pus. Control over the anus was slowly regained, and the patient was discharged "cured" at the end of six weeks.

In some cases it is found that after replacement of the prolapse, the sphincter is weak and patulous ; such cases may be due simply to dilatation by the prolapsed portion of mucous membrane, and will, in this case, recover soon after the condition of the membrane has been remedied. In other cases, however, the sphincter may be permanently relaxed or may be paralysed. In such cases further treatment to the anus itself will be found necessary. This treatment may be along two lines :

1. Excision operations.
2. Injection of paraffin beneath the mucous membrane.

1. **Excision Operations.**—Oval areas of skin and mucous membrane are removed, the long axis of the oval passing from the skin of the perineum, across the anal margin, to the prolapsed mucous membrane. The widest area of the oval is made at the anal junction. Two flaps are usually removed, and one of them may be sufficiently deepened to include a portion of the sphincter. The areas are then sewn up transversely, the anus thus being narrowed. The operation resembles that of perineo-colporraphy, as applied to prolapse of the uterus. It must be distinguished from the old operation of excision of oval flaps of mucous membrane alone for cases where the anus was not affected; such are unnecessary, for should these cases not yield to treatment with the cautery, they will usually require the form of excision described previously.

Mayo Robson (*Pract.*, February, 1903) has described an operation of making a semilunar incision parallel to the anterior margin of the anus; this is deepened, and if necessary the sphincter reconstructed, and the wound is then sewn up transversely.

2. **Injection of Paraffin.**—This method, perfected by Mr. Stephen Paget, has for its object the replacement of a flexible tube, capable of being inverted, by a hard and rigid tube, and has been used by him with success in cases where operative treatment had failed.

The paraffin used should have a melting point of between 110° and 120° F. It should, of course, be carefully sterilised, being conveniently kept in sterilised bottles. Before use it may be liquefied by placing it in hot water. A metal syringe, also heated, should be used, and to prevent rapid cooling of the needle, and consequent setting of the paraffin within it during use, this may have a thick metal collar up to within a half or quarter inch of the point, as advised by Mr. Stephen Paget.

The patient is anæsthetised and placed in the lithotomy position. The rectal mucous membrane is then pulled down as far as possible, and the paraffin injected in two or three areas under the highest part of the mucous membrane. This is then

replaced, and the injection again carried out, and continued until the level of the anus is reached. Paget states that the paraffin must be kept away from the urethra and bladder. Burgess (*Lancet*, 1904) advises that the paraffin should be injected in three places equidistant from one another round the lumen of the gut, so that when the paraffin is injected a triangular slit is formed. This is repeated lower down, but so that the apices of this triangle are opposite the bases of the first triangle. Three tiers are usually sufficient. The patient is kept in bed and the bowels are allowed to act spontaneously. The good results are said to be immediate.

Comment.—Of the value of the measures above described considerable differences of opinion have been expressed.

Speaking from our own experience of these operations, we would venture the opinion that the treatment by strong nitric acid is barbarous and uncouth, and a survival of the surgery of past ages. It is very painful. It has been followed by sloughing and acute inflammation of the rectum, and has led to severe, and even fatal, hæmorrhage, and also to stricture.

The treatment by means of the actual cautery appears to be fairly well suited to mild forms of the trouble which have resisted all modes of treatment short of those by operation. The measure is painful, a severe degree of inflammation is excited, some sloughing is inevitable, and the special dangers of a burn are introduced. The depth of the burn is not easily regulated, and stricture may form on the one hand or a relapse occur on the other.

For severe cases the treatment by excision is distinctly the best.

A clean incision is made, the operation area is reduced to a minimum, no damaged bowel is left in the pelvis, hæmorrhage may be rendered practically impossible, and the after-treatment is of comparatively short duration.

Inasmuch as the parts are cleanly excised, and the whole of the operation is conducted without the anus, the risk of subsequent stricture must be small. As regards the operative

treatment in the more severe cases, where changes have occurred in the anal canal and sphincters, it is doubtful if much permanent good can be done by a plastic operation, for the sphincter, even if sufficiently shortened at the time of operation to remedy the prolapse, in time, if the contractile power is lost, gradually yields, and the prolapse returns.

The method of paraffin injection seems at first sight to be a satisfactory one of dealing with the condition, but the following questions have to be considered.

Is it reliable and permanent? Those who have carried it into effect claim that it is immediately followed by good results, and satisfactorily keeps the mucous membrane in its normal position. As to its permanency, little can as yet be said. Cases have not yet been observed long enough for a just conclusion to be arrived at, but some have been reported where paraffin has been injected under the skin and has ultimately been absorbed, and the operation has had to be repeated; and this material has been used to fill bone cavities, it being in time satisfactorily absorbed and replaced by new bone. So that by analogy it would appear that the operation is only temporary and might have to be repeated, and it might have to be left to the patient to decide whether these repeated operations, small though they might be, would be of less inconvenience to him than the presence of the prolapsed rectum.

If permanent, is it free from risk? Sepsis and embolism have followed soon after the use of this method. If proper precautions are taken, the risk of this sequela should be small, but it has to be considered; whether, if permanent, it would later lead to suppuration or ulceration cannot yet be determined. The paraffin may itself, as a foreign body, lead to dangerous symptoms. Thus, if care be not taken to avoid the urethra and bladder, these structures may be compressed, and cases have also been recorded where its use for prolapse of the uterus has been followed by obstruction of the large gut. At present, therefore, this method is still upon trial, and should not be too readily accepted.

CHAPTER XXXIV

EXCISION OF THE RECTUM

EXCISION of the rectum, or proctectomy, is carried out in certain cases of malignant disease involving the lower part of the rectum. The operation has also been employed in examples of extensive and intractable non-malignant stricture of the rectum, especially when associated with widespread ulceration. As, however, such applications of the procedure are exceedingly rare, the present chapter will be confined to excisions performed in cases of cancer.

The term excision of the rectum is a little misleading, inasmuch as the excision seldom involves the entire rectum, as it is anatomically defined. It is usually restricted to the removal of a comparatively small part of the bowel.

The operation is the subject of very considerable differences of opinion, these differences being for the most part concerned with the advantages to the patient to which the operation may lay claim.

The value of the procedure is discussed in subsequent sections, and it is only necessary to say here that excision of the rectum is not to be lightly undertaken, and that the measure has been distinctly disappointing in its results. In not a few instances the patient has gained little from the operation but increased discomfort, and his life has been extended for no longer a time than would have attended a simple colotomy. Many cases, however, which have been treated by one or other of the methods described below can now be claimed as cures—*i.e.* there has been no sign of recurrence after three years,—and although the majority of such are undoubtedly selected cases, yet such evidence as they afford is strongly in favour of a radical operation being

done, provided that the disease is seen at an early enough stage.

The operation appears to have been originally performed by Paget in 1763. It was, however, little noticed by surgeons until the procedure was revived by Lisfranc in 1830. The method adopted was that known as the perineal operation.

A new aspect was given to the procedure by Kraske, who introduced sacral proctectomy and carried out his first operation successfully in 1885 (*Arch. für klin. Chir.*, 1886, Bd. xxxiii., page 563). Conspicuously associated with the development of the operation must be mentioned the names of Czerny, Heinecke, Kocher, Hochenegg, Heuston, and Ball.

Indications for the Operation.—The cases suitable for this operation are those of cancer of the rectum in which the growth is in an early stage, is small, and is quite limited to the rectum. Its position, and the extent to which it may extend along the bowel, are not in themselves counter-indications to operation. The presence of secondary deposits in the lumbar and sacral glands or in the liver prohibits interference. In the case of anal epitheliomata, the inguinal glands must be removed, even if not palpable. The operation is not to be carried out when the malignant growth has extended beyond the rectal wall and has invaded the surrounding connective tissue, or has made its way to the prostate, bladder, uterus, or vagina. Carcinoma is met with in all parts of the rectum, but is more frequently located in the lower two or three inches of the bowel.

For the purposes of this operation the following classification by Quénu (*Presse Médicale*, November, 1895) is of value:—

1. Cancers of the anus, growths which have involved the bowel below the attachments of the levatores ani.

2. Cancers which occupy the suprasphincteric zone of the rectum, but are infraperitoneal.

3. Cancers placed high up in the bowel, their lower limit being above the level of the peritoneal *cul-de-sac*.

4. Cancers which extensively involve the rectum, reaching from the anus to a considerable distance upwards.

In cases in which the growth is situated high up in the rectum, or in the lower part of the pelvic colon, or in early cases where there is only a suspicion of such growth, a preliminary sigmoidoscopy must be done. The patient is prepared as below for operation, an anæsthetic is administered, he is placed in the lithotomy position. The sigmoidoscope is then passed with the obturator in position. When it has been passed three or four inches the obturator is withdrawn and air pumped in by means of the hand bellows. The instrument is then gently passed up, the surgeon meanwhile aiding its passage by sight, each portion of mucous membrane being examined as it comes into view. A growth may by this means be diagnosed quite early; or in the case where the presence of the growth is known, its position and extent accurately determined. This operation, simple though it may seem, is not unattended with risk, and the practice now unfortunately arising of passing the instrument without an anæsthetic by those who would be ill prepared to do a laparotomy is much to be deprecated. Several cases have occurred, and a few have been reported, where, by the use of this instrument, perforation of the bowel has taken place; and since, in cases where the symptoms are such as to suggest the presence of a new growth of the rectum, the condition of the walls of the bowel cannot be determined, it is preferable that it should be passed only as an immediate preparatory measure to excision of the growth, if such be found. Then, if the above disaster occur, it can be readily and rapidly dealt with.

Preparation of the Patient.—A few days' rest in bed previous to the operation is of considerable service. The diet should be of the simplest kind, and of a type which will leave the least possible residue in the bowel. If the patient has very defective teeth, all food requiring careful mastication should be avoided. Such patients therefore will be denied all meat. The bowel should be well cleared out by aperients, and repeated enemata given by means of a carefully graduated douche.

It may be necessary to pass a small rubber tube through

the stricture in order the more effectually to wash out the bowel.

The use of certain reputed "intestinal antiseptics" is advised by many writers, such as resorcin, salol, β-naphthol, and salicylates of bismuth or quinine. For this purpose, Hofmann advises the use of isoform in ½-gramme doses, given at four-hourly intervals, until three grammes have been administered, and has recorded a series of observations upon cases where its use was followed by a marked decrease in the number of bacteria in the intestinal canal.

A preliminary temporary colotomy is proposed by some surgeons, but has little to recommend it. Such a measure is an indifferent preparation for the major operation; it involves a waste of time, it may prevent the complete pulling down of the gut during the excision, and it cannot be said to be of any material help to the surgeon. It necessitates at least two extra operations, one for the formation of the opening, and one for its closure. A preliminary colotomy may be needed in cases in which obstruction exists and in which the bowel cannot be emptied by either aperients or enemata. In such examples, however, it is more than probable that the disease is so advanced as to render excision unjustifiable. A permanent colotomy may be carried out with advantage in certain cases, and some surgeons advise that this should be done in all cases, for they claim, with justification, that in only a few cases is control gained after excision, and that incontinence from an inguinal opening is more readily controlled than from an anal one. By the use of some modification of Allingham's tube, which is worn as an anal plug, the condition of the patient is, however, usually more comfortable—anyhow from a psychical point of view—with the anal opening. This refers only to those cases where the permanent operation is done in addition to excision of the growth, and not to those where the disease is so advanced that colotomy can alone be carried out.

Some writers recommend a curetting of the growth as a preliminary to the excision. There is, however, nothing to

commend this measure, which is not free from risk, and which may involve troublesome bleeding.

Instruments Required. — Clover's crutch; curved sharp-pointed bistoury; straight probe-pointed bistoury; scalpels; straight blunt-pointed scissors; scissors curved on the flat; two pairs of volsella forceps; dissecting forceps; a liberal supply of pressure forceps; artery forceps; sponges in holders; rectal speculum; syringe; Paquelin's cautery; ligatures; curved needles. *For the sacral operation*—in addition, suitable metal retractors; periosteal elevator or rugine; small saw; bone-cutting and bone-holding forceps; chisel and mallet; bone gouge.

The following operations will be described :—

1. The operation for anal cancer.
2. Excision of the rectum by the perineal route.
3. Excision of the rectum by the sacral route (Kraske's operation).
4. Excision by abdominal section.
5. Excision of the rectum by the perineo-abdominal method.
6. Excision in the female by the vagina.

I. THE OPERATION FOR ANAL CANCER

The patient is placed in lithotomy position. The rectum is washed out and the skin around the anus cleansed and shaved.

With a scalpel an incision is made around the anus and in the skin at a distance which will be well clear of the disease. This incision is deepened all round, and the anal tissues are gradually separated. This separation is effected by blunt-pointed scissors aided by the finger. The attachments of the gut are cleared on all sides for some little way above the line of intended division. The division is made with scissors through healthy tissue and in a line at right angles to the long axis of the bowel. Bleeding vessels are secured by pressure forceps. By means of a curved needle in a handle the divided mucous membrane is secured to the divided skin by means of a series

of deeply-placed dry catgut sutures. These sutures are so placed with reference to the severed vessels that the same are occluded when the knots are drawn tight. Some surface sutures of finer gut will be needed to make complete the line of union.

The inguinal glands should be removed, and this should be done preferably ten to fourteen days after the operation on the anus. If done at the same time as or earlier than this, there is the possibility that the wound will be infected by septic or cancerous material passing along the lymphatics from the anal wound.

The *after-treatment* is identical with that observed after Whitehead's operation for piles (page 720).

2. EXCISION OF THE RECTUM BY THE PERINEAL ROUTE

Two varieties of this operation have to be considered.

A. Partial removal of the rectum for growths situated low down, whereby the sphincter may or may not be preserved.

B. The method as advocated by Lockhart-Mummery for complete removal of the rectum and preservation of the sphincter.

A. **Partial Removal.**—The patient is prepared in the manner described on page 742, is anæsthetised, and is placed in the lithotomy position, the lower limbs being secured by means of Clover's crutch.

A good light is required, and at least one thoroughly efficient assistant. If the growth is low down and the sphincter has to be sacrificed, a curved incision is made round either side of the sphincter; these two are joined behind and carried back to the coccyx. If, however, the growth is higher up, Quénu's method is used. The mucous membrane in the lower part is dissected off and ligatured with a purse-string suture; the oval incision is then carried backwards to the coccyx and forwards nearly as far as the scrotum, the two halves of the sphincter being left on either side of the wound and after-

wards sutured. By deepening the posterior incision the rectum can be freed on its posterior and lateral aspects, and the levator ani divided on each side by passing a finger over the posterior border. The rectum is then separated from the sacrum and loose pelvic connective tissue with the finger and by blunt dissection.

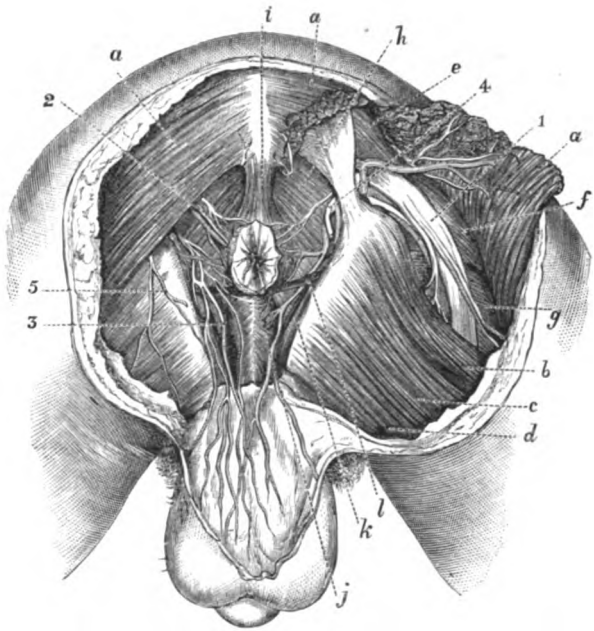


FIG. 192.—PERINEUM OF THE MALE, SHOWING THE SPHINCTER AND LEVATOR ANI, ETC., WITH REFERENCE TO EXCISION OF THE RECTUM. (*After Rüdinger.*)

a, Gluteus maximus; *b*, Semi-tendinosus and biceps; *c*, Adductor magnus; *d*, Gracilis; *e*, Pyriformis; *f*, Obturator internus; *g*, Quadratus femoris; *h*, Levator ani; *i*, External sphincter; *j*, Accelerator urinæ; *k*, Erector penis; *l*, Transversus perinei. 1, Great sciatic nerve; 2, External hæmorrhoidal vessels and nerve; 3, Superficial perineal vessels and nerves; 4, Pudic nerve (cut) and pudic artery; 5, Pudendal branch of small sciatic nerve.

The next step is the difficult one of separating the bowel from its anterior connections. In the case of a male subject this is much facilitated by having a full-sized catheter passed into the urethra, and held in the position of the staff in lithotomy. In the female, the finger introduced from time to time into the vagina will afford valuable guidance. Should the

vagina itself be involved, this portion must be freely removed, and the opening so made sutured at the end of the operation. The portion of the bowel already detached is held by an assistant, who draws it downwards. The surgeon proceeds to separate the gut from its anterior connections by means of blunt-pointed scissors, aided by the left fore-finger.

When the rectum has been freed all round, well above the upper limits of the disease, the gut is cut across transversely by scissors. The section should be made, if possible, at least one inch above the growth. The division should be made cautiously and in sections, and all bleeding vessels are secured at once with pressure forceps. These forceps serve also to maintain a hold upon the divided intestinal wall. The wound-cavity is now syringed out and dried. The vessels held by the pressure forceps are secured as required ; some will have been already closed by pressure, others can be dealt with by torsion, and the remainder by ligature.

The hæmorrhage varies a great deal ; but as the chief bleeding vessels are situated in the wall of the bowel, they are readily secured. Such venous oozing as exists will usually yield to pressure, and in any case will cease, more or less completely, when the body is put out of the lithotomy position. The use of the cautery should be avoided whenever possible. It obscures the anatomical details of the parts, involves sloughing, and necessitates much after-contraction of the wound.

The two sides of the levator ani are now sewn to one another and to the wall of the rectum, so as to repair as far as possible the pelvic floor.

Much difference of opinion exists as to the manner in which the operation should be completed. Some surgeons advise that the mucous membrane should be drawn down, and attached to the skin at the anal margin by means of a close row of sutures. If this be done the sutures must take hold not only of the skin and the bowel wall, but also of the surrounding pelvic tissues. Drainage tubes will also need to be inserted here and there

between the sutures; and the edges of the sphincter, if this has been divided, should be united with catgut sutures. Other surgeons condemn this measure, and state that the stitches are sure to give way; that so long as they hold they prevent a free discharge from the wound, and permit spaces to form outside the bowel.

This objection is not well founded if the wound be carefully drained and well attended to.

Those who advise the suturing of the divided parts claim that the wound surface is thus greatly diminished, that the duration of the after-treatment is shortened, and that the tendency to stricture is obviated. That the slow closure of a long track in the rectum by the process of granulation may lead to stricture cannot be denied.

Ball points out that a great deal depends upon the manner in which the sutures are introduced. If the skin and the margin of the gut be merely sutured together, then pouches will certainly form outside the bowel, and the hold of the sutures will be slight. If, on the other hand, the threads be passed deeply through the surrounding pelvic structures as well as through the skin and mucous membrane, then the stitches will be scarcely able to cut their way out, and no pockets for pus can be left outside the bowel.

Mr. Bidwell (*Brit. Med. Journ.*, Oct. 21st, 1899) advises that two transverse incisions some two inches long should be made on each side of the perineal incision. The flaps of skin so formed are then dissected up and attached to the cut end of the rectum by silkworm-gut sutures. This can usually be carried out without undue tension.

The operation as above described applies to the removal of the whole circumference of the bowel.

It is needless to say that no more should be removed than is consistent with a free, complete, and proper excision of the growth, and that the preservation of any part of the anal margin is always desirable. Unfortunately, it is not often possible to follow this course.

If only a little of the anal margin can be preserved the amount of the after-contraction is considerably lessened.

B. **Complete Removal.**—In this operation, as advocated by Lockhart-Mummery (*Brit. Med. Journ.*, June, 1907), the whole of the rectum, and even part of the sigmoid, together with the neighbouring lymphatic area, are removed by the perineal route.

The first steps in the operation are similar to those by Quénu's incision (page 744), with the exception that the posterior incision is carried back as far as the base of the coccyx, which structure is then removed. After separation of the connective-tissue attachments of the rectum in front and behind, the peritoneum is opened first in the anterior *cul-de-sac*, and then on either side as close to the rectum as possible, so as to avoid injury to the ureters. The rectum will now come down several inches, being only attached by the meso-rectum. This is clamped as near to the sacrum as possible, and then divided in front of the clamp. The rectum now descends freely, and the sigmoid comes into view. The meso-sigmoid must now be divided until a portion of the sigmoid is reached which has a sufficiently long mesentery to reach the anus easily and without dragging. This is between 3 and 8 inches above the junction of the rectum and sigmoid. The meso-sigmoid is clamped and divided until a sufficiently long piece of mesentery is found. The whole of the rectum and growth are now outside the wound, and the former is cut across with scissors. The clamps have to be tied off, and this is often difficult, as they are a considerable distance from the surface, and it is not easy to pass a ligature around their upper ends. No mistake must be made, as there are large vessels in them, and hæmorrhage might be difficult to control in so deep a wound. The peritoneal floor is repaired by stitching the peritoneum all round to the sides and front of the sigmoid. Some sterilised gauze is placed in the wound and the end brought out at the posterior part. The rest of the wound is sewn up completely, and the sphincters are carefully brought together and sutured. The wound and sigmoid nearest

to it are smeared with sterilised iodoform ointment. The bowel is cut through three-quarters of an inch from the anus, and the edges roughly stitched to the skin all round, half an inch or more from the edge of the skin wound. Hence the wound and peritoneum are separated from the septic mucous membrane. A week later the excess of mucous membrane is cut away with scissors. Care must be taken not to divide the gut beyond the attachment of the meso-sigmoid, and to see that this structure is not on the stretch, otherwise a portion of the gut will slough. A piece of rubber tube is placed in the bowel and packed round with gauze. The wound is then dressed.

The dressings should be changed daily, and the patient should be sat up as soon as possible. It is very important to avoid retention of urine, and for the first few days the catheter should be passed regularly. The bowels are kept confined for six days and then opened with castor-oil and an olive-oil enema. After the first week the bowels are kept acting by daily enemata.*

3. EXCISION OF THE RECTUM BY THE SACRAL ROUTE

The bowel may be reached in two ways :—

A. By definite sacral resection (Kraske's operation).

B. By temporary sacral resection or by a parasacral incision.

The full description of the operation will be given in connection with the first-named of these methods, which

* The special point of the above description, which is condensed from a long and fully illustrated account by Mr. Mummery (*loc. cit.*), is that a very extensive removal of rectum is carried out through a comparatively small perineal wound, and that consequently the manipulations required to bring the sigmoid flexure down must be done mainly in the dark. This is a great disadvantage, and it seems to us that the combined abdomino-perineal method, such as is described by Miss Blake (page 758), is much better. Of course either form of operation is a long and tedious one, involving considerable loss of blood and shock, and the mortality attending it must always be high. The great advantage offered is that no artificial anus remains and that ultimately more or less control over the "rectal" functions may be regained. (*See* the discussion of the various methods on page 760.)

may be described as Kraske's operation as now usually practised.

A. **Kraske's Operation — the Method by Definite Sacral Resection.**—The purpose of this operation is to obtain a free access to the diseased bowel from the sacral side, to remove it liberally, and to preserve at the same time the sphincteric function of the rectum.

Position of the Patient.—The patient is prepared as described on page 741. The skin of the operation area will have been shaved and well cleansed. The patient lies upon the right side with the knees drawn up and with the buttocks projecting over the foot of the table. The buttocks are well raised upon a large, hard, solid cushion or sand-bag. The surgeon sits facing the foot of the table. This position of the patient is retained until the rectum is well exposed and the posterior part is freed. During the remainder of the operation the patient is placed in the lithotomy position with the pelvis well raised upon a firm support.

Some surgeons keep the patient in the lithotomy position throughout the whole operation from the commencement to the end.

Others place the patient from the commencement upon the face with the lower limbs—suitably supported and secured —hanging over the foot of the table, and the pelvis, therefore, at the very edge of the table. This position has great disadvantages during the later stages of the operation, and considerably embarrasses the work of the anæsthetist.

The operation is carried out in three stages :—

(1) The exposure and separation of the bowel.
(2) The removal of the bowel.
(3) The treatment of the divided ends of the bowel.

(1) *Exposure and Separation of the Bowel.*—When the patient is in position the bowel may be finally irrigated with 1 in 5,000 perchloride of mercury solution, and dried with iodoform gauze, a light plug of which may be allowed to remain in the gut.

An incision is made in the median line from the posterior edge of the anus to the centre of the sacrum. The knife passes to the bone at once. The soft parts on the left side of the wound are detached *en masse*, and drawn outwards. They include part of the gluteus maximus. The left side of the sacrum is thus bared and brought well into view. The sacro-sciatic ligaments attached to this left border are divided, as are also

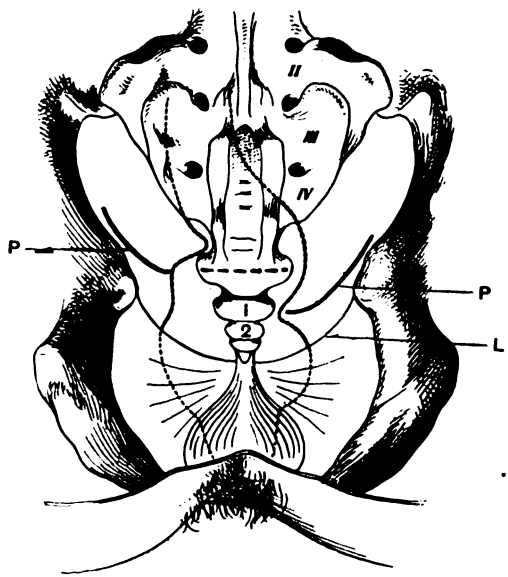


FIG. 193.—DIAGRAM OF RECTUM FROM BEHIND. (*After Hartmann.*)

P P, Level of reflexion of peritoneum; L, Upper edge of levator ani. The dotted line across the last piece of the sacrum indicates the best level for excision of the bone.

the ligamentous attachments on both sides of the coccyx. The coccyx is now freed on all sides from its muscular attachments, and is left bare. The soft parts in the hollow of the lower part of the sacrum are detached with a rugine. They include the sacra media vessels and the venous plexus which lies in front of the sacrum. The coccyx is now removed entire.

Should sufficient space to reach the diseased segment of the rectum not be provided, a portion of the left side of the sacrum is removed. Bardenheuer takes away the whole lower

part of the bone as far as the third sacral foramina, whilst another surgeon advocated a still higher resection (*see* Fig. 193). The higher the division the greater the risk. The soft parts are more fully retracted on the left side, and the sacrum is divided along a curved line, which commences at the left margin of the bone at the level of the third posterior foramen, runs downwards and inwards to the right of the fourth foramen, and ends at the lower border of the fifth sacral vertebra. This division of the bone is carried out by means of a gouge or a chisel and mallet, according to the surgeon's familiarity with those instruments in dividing bone.

It will be observed that the anterior division of the third sacral nerve is not severed, and that the sacral canal is not opened. The bleeding (which may be free) is largely venous, and yields to pressure.

The opening obtained by the removal of the bone gives access to some six or eight inches of the bowel, and allows of a free removal of the diseased segment.

The operator now divides the tissues over the rectum in the posterior median line, such section including the levatores ani. He clears the bowel posteriorly. When that is accomplished, the patient is placed in lithotomy position with the pelvis well raised, and the attachments of the rectum are approached anteriorly. The separation of the bowel is effected by the fingers, aided by blunt-pointed scissors and occasional dissection, and great care must be taken of the urethra and prostate in the male, and of the vagina and uterus in the female.

In the male subject a sound is introduced into the urethra as a guide, and in the female a frequent digital examination through the vagina will notify an encroachment on that passage.

The separation of the rectum must be carried out with great care, and on no account must the bowel be forcibly dragged upon. The complete separation of the rectum anteriorly cannot be effected until the bowel has been divided below, and until, indeed, its removal is in progress.

(2) *Removal of the Bowel.*—Wherever possible the anus should be left intact. If the growth does not reach to within one inch of the external sphincter, then that muscle and the anus may be left undisturbed.

The rectum is divided first of all transversely below the growth, and the section should be, if possible, one inch below the margin of the cancer. The best case, therefore, for the operation—other things being equal—is one in which the lower edge of the growth is two inches from the anus.

Before the bowel is divided, it should be clamped or ligatured below the growth in order to prevent any escape of matter from the interior.

The complete separation of the bowel anteriorly is now proceeded with.

In due course the peritoneum will be reached as it is reflected from the anterior wall of the gut. If the growth be low down, the bowel may be cleared at a sufficient height by merely pushing up the serous membrane without opening it. If this is, however, not possible, the peritoneum must be freely divided. The gut is now retained in place by the meso-rectum. This structure, together with the presacral connective tissue, is separated from the hollow of the sacrum, and the bowel thus freed is drawn down into the wound.

The bowel is isolated with greater ease as soon as the peritoneum is opened, and in any case of high carcinomatous stricture the surgeon should deliberately do this as early as possible. The fingers of one hand then draw the bowel forward, whilst a narrow-bladed clamp is applied to the meso-rectum and the latter is divided as far up as necessary. This proceeding facilitates the upper part of the rectum and the lower end of the sigmoid being drawn well down, so that the surgeon can divide the intestine wall above the cancer.

The rectum is now clamped at a point from an inch to an inch and a half above the growth, and is divided close to the lower edge of the clamp, care being taken, by means of a liberal plugging of gauze all round the seat of

section, that none of the contents of the gut escape into the wound cavity.

As the final attachments of the bowel are severed, any bleeding vessels are seized with pressure forceps. Great care must be taken to preserve intact the vessels which pass through the meso-rectum to such part of the bowel as is left behind. If heed be not paid to this the rectal stump may slough. The stump of the rectum is well dried and washed with a 1 in 2,000 solution of perchloride of mercury. The opening into the peritoneal cavity—if such has been made—should be closed by means of a continuous silk suture, which can be rapidly introduced. Kraske advises that this opening should be merely plugged with iodoform gauze, but the protection of a line of suture is very much to be preferred, and should always be attempted.

(3) *Treatment of the Divided Ends of the Bowel.*—Whenever it is possible, immediate direct suture of the divided ends of the bowel should be carried out. The gut above the growth thus comes to be attached to the sphincter and the anal part of the rectum. When the sphincter and anus have been left untouched, the anterior and lateral portions of the rectum are united by two rows of sutures, one involving the whole thickness of the gut and the other the mucous membrane only. The posterior portion—which is necessarily dealt with last—is closed by deeply-placed sutures which do not reach to the mucous membrane. When the sphincter and anus have been removed, the attempt should be made to unite the severed bowel to the skin.

In such case the free end of the bowel is fixed to the skin at the posterior angle of the wound by numerous deep and superficial sutures. In this way the "sacral anus" as recommended by Hochenegg (*Brit. Med. Journ.*, vol. i., 1900, page 1031) is made.

When the bowel is about to be attached to the skin, Gersuny (*Zentral. für Chir.*, 1893, No. 6) recommends that the upper end of the gut, if long enough, should be twisted upon itself

before it is fixed to the skin by sutures. It is seized by forceps, and is rotated around its own long axis, until resistance is offered to the attempt to introduce the finger into the bowel. The gut is fixed to the skin in this twisted condition, and the escape of its contents is said to be hindered.

Willems (*Zentral. für Chir.*, 1893, page 401) and Witzel (*Zentral. für Chir.*, 1894, No. 40) have treated the lower end of the rectum by drawing it through an aperture made in the lowest part of the gluteus maximus before uniting the divided surface to the skin. It is assumed that the fibres of the gluteus muscle will have some sphincteric action.

Other methods of dealing with the severed bowel are described. Thus Paul (*Lancet*, vol. ii., 1897, page 78) does not attempt approximation of the divided ends if more than three inches of the bowel have been removed. He introduces a large glass drainage tube into the wound. The upper end of this tube enters the bowel, and is secured to it by means of a ligature. The divided end of the gut is sutured to the uppermost corner of the wound. The tube comes away about the fourth day. For the union of the severed gut, Murphy's button, and also the bone bobbin, have been used with success. It is only in exceptional cases, however, that they can be employed.

Other surgeons perform a preliminary inguinal colotomy, and entirely close the divided end of the bowel. This method has very considerable and obvious advantages, and will be alluded to subsequently (page 759).

After-treatment.—It will be obvious that the main feature of the after-treatment consists in the most careful attention to the wound. It should be very frequently irrigated with dilute perchloride of mercury solutions, and should be kept as dry as possible. A constant outlook should be maintained for retained secretions or retained pus. The wound (within reasonable limits) cannot be dressed too often. If the bowels have been very well evacuated before the operation, they may be kept confined for the first six days after the operation. Some surgeons would extend this period to eight days. It is impossible,

however, to follow any rule in these cases, especially in those in which there has been considerable irritation of the bowel above the stenosed part. In any case the fresh irrigation of the wound must follow every action of the bowels. A catheter will probably need to be employed for the first few days.

The position of the patient will need to be frequently changed in order to secure efficient drainage.

The patient will have to be kept in bed until the process of granulation is well advanced. As soon as he is able to move, a daily hip-bath is an advantage.

The anal passage must be frequently examined for stricture, and any threatened narrowing met by the passage of bougies or by other measures.

Numerous pads, plugs, trusses, and belts have been devised to meet the incontinence of fæces which is common after these operations.

B. **The Operation by Temporary Sacral Resection, or by a Parasacral Incision.**—In the operations of the first series the bone is divided, and a long flap is turned back which is replaced as soon as the excision of the rectum has been completed. The intention is to provide a wound the healing of which will be more ready, and at the same time to disturb as little as possible the support of the pelvic viscera. There are many methods.

Heinecke (*Münch. med. Woch.*, 1888, No. 37) divided the sacrum transversely below the fourth foramen, and made a second section of the bone vertically in the median line from the tip of the coccyx to the centre of the horizontal incision. The cuts in the bone, therefore, formed a T. The two triangular osteo-integumental flaps thus made were forcibly turned outwards and the rectum exposed. After the excision the flaps are replaced.

Heinecke's operation was the first of its kind, and has been the subject of numerous somewhat unimportant modifications. The modifications are chiefly concerned with the placing of the bone incisions.

The best, however, of the osteo-plastic methods is that known

as the operation of Reyn (*Beilage zum Zentral. für Chir.*, 1890, No. 25) and Rydygier ("Manual of the Universal Medical Sciences," 1894, vol. iii.).

An incision is commenced at the left posterior superior iliac spine, and continues along the left side of the sacrum, about half an inch from the margin of the bone. It reaches the coccyx, and is prolonged in the median line to the anus. At the upper end of the wound the margin of the sacrum is exposed, and the sacro-sciatic ligaments are divided. The anterior surface of the sacrum is cleared of the tissues which cover it, and a transverse incision is carried across the bone just below the third sacral foramina. This incision is made with a chisel. The triangular flap thus marked out is turned over to the right side, and is replaced after the excision of the bowel has been completed.

In general terms it may be said that the formation of osteo-integumental flaps is good in theory. It spares the absolute removal of healthy parts, it leaves but little disturbed the actual long and ligamentous floor of the pelvis, and it affords good support to the viscera. If, however, the wound become infected, necrosis of the replaced bone may follow. The wound is apt to be so narrowed as to hamper an efficient drainage, and, above all, the measure is not possible when a sacral anus has to be made.

In the parasacral method the bowel is reached by means of a free incision made along the border of the sacrum, and penetrating to the pelvis. The incision commences at the posterior superior spine, and ends midway between the anus and the tuber ischii.

Zuckerkandl followed the left border of the sacrum in performing this operation, and Wölfler followed the right. Wölfler in addition removed the coccyx.

4. EXCISION OF THE RECTUM BY ABDOMINAL SECTION

This method has been used for growths situated in the upper part of the rectum, where removal by the perineal or sacra

routes would be difficult. But unless situated sufficiently high to allow of an end-to-end anastomosis being readily undertaken after removal, it will be preferable to use the perineo-abdominal method (*see* below).

The bladder and rectum must be empty, and the patient is placed in the Trendelenburg position; an incision is made through the left rectus and carried as low down as possible. The growth is examined, and for this purpose must be brought well into view. The gut is now clamped above and below the growth, the wound and peritoneum being protected as far as possible from infection by means of sponges. The ends of the gut may be now united either by suture, if possible, or with the aid of Murphy's button or of a bone bobbin, or Kelly's method may be used. Here the lower end is sutured, a lateral opening is made into it, and the upper portion of the gut invaginated through this. It is fixed in position by sutures between the two walls, and by long sutures from the apex of the invagination being passed outside the anus and kept in position by forceps. Thirdly, Paul advises that the lower end should be ligatured, and the upper end taken out through and fixed in a small wound in the inguinal region.

5. EXCISION OF THE RECTUM BY THE PERINEO-ABDOMINAL METHOD

In this procedure the rectum is excised partly through the abdomen and partly through a perineal incision.

There have been many modifications introduced, but the one which gives the most complete removal and restores the parts to their most physiological condition is the following, introduced by Miss Aldrich Blake (*Brit. Med. Journ.*, 1903):—

The patient having been prepared as above, is placed in the Trendelenburg position, a median incision is made and the peritoneal cavity opened. At this stage both internal iliac arteries may be ligatured if desired. A U-shaped incision is made in the pelvic peritoneum around the rectum, and this viscus is separated by blunt dissection from the pelvic diaphragm; the

peritoneum to the left of the sigmoid and close to the parietes is then incised. The vessels may be left uninjured, but it will probably be found necessary to ligature those going to the upper part of the returning loop; and, as advised by Sir Charles Ball, it is best to ligature and divide the vessels to the lower part, for the portion of the sigmoid opposite the greatest length of its meso-colon is that which is ultimately stitched to the anus, irrespectively of the position of the growth. By this means the lower part of the sigmoid may be straightened out sufficiently for the centre of its loop to be brought down to the tip of the coccyx without tension. The rectum with its mesentery and any enlarged glands are pushed beneath the pelvic peritoneum, the edges of which are sutured together and to the peritoneal covering of the sigmoid. The abdominal wound is completely closed and dressed.

The patient is now placed in the lithotomy position, and Quénu's anal incision made, the lower part of the rectum is liberated, drawn out of the wound, and removed at a level which allows of the upper end being fixed *in situ* without tension. This divided end of intestine is then sutured to the skin, or, as in Miss Blake's case, to the anal mucous membrane, about three-quarters of an inch above the anal margin, which had been left behind when the rest of the rectum was removed. The sphincter is now carefully sutured both in front and behind. The rest of the wound is then united, except for a small area through which a tube is inserted for drainage. The bowels are opened on the sixth day.

In the method advocated by Quénu, the bowel is divided above the growth from within. The upper end is brought out in the left iliac region and constitutes the permanent anus. The lower end is freed by dividing the meso-sigmoid and meso-rectum along the entire length of the hollow of the sacrum. The patient is then placed in the lithotomy position, and the lower freed portion, together with the sphincters, excised by way of the perineum.

By this means the whole growth is removed with but

little shock, but at the expense of a permanent colotomy wound.

6. EXCISION IN THE FEMALE BY THE VAGINA

This method advocated by Murphy is chiefly indicated where the vaginal wall is adherent to the growth.

The patient is prepared in the usual way and placed in the lithotomy position. The vagina having been dilated, the cervix is drawn downwards and forwards, the vagina is incised transversely in the posterior fornix, the pouch of Douglas being opened. An incision is then made at right angles to this along the posterior wall of the vagina as far as the anus. The mucous membrane of the anal canal is dissected off and ligatured. The vaginal wall is dissected off the anterior wall of the rectum, and if affected is removed. The rectum is then freed posteriorly and laterally as in the earlier stages of the complete removal by way of the perineum (*see* page 748). The rectum can now be drawn down, and the peritoneal sac is rejoined by suture, the bowel is divided well above the growth, and the cut end sutured to the anal margin. Finally the vaginal wall and perineum are sutured.

COMMENT UPON THE OPERATION OF EXCISION OF THE RECTUM

The operation for the removal of well-defined epitheliomata of recent standing in the anal region calls for no comment.

It is an excellent measure, which should be carried out in every instance as soon as the growth is discovered.

No exception can be taken to the excision of a cancer of the rectum by the perineal route when the growth is low down, is in an early stage, is entirely limited to the bowel wall, and can be thoroughly and entirely isolated. The mortality in cases of perineal excision would appear to be about 7 per cent.

Considerable differences of opinion, however, exist as to the value of the more extensive operations for the excision of the rectum, and the main discussion now centres around the methods

of removing the rectum by the perineal and perineo-abdominal routes.

In contrasting them with colotomy, it must be remembered that they aim at procuring complete removal of the growth and permanent cure, whilst colotomy aims only at relieving the patient of his symptoms and prolonging his life for a few months. Unfortunately, the number of cases treated by these means, although very satisfactory as far as they go, are at present too few for any accurate conclusions to be based upon them, and hence in taking statistics one has to rely largely upon the older methods, such as Kraske's operation.

In favour of the operation it has to be pointed out that the malignant growth which is the subject of the excision is an epithelioma, that a very large measure of success attends the removal of epitheliomata in other parts, and that that success is pronounced in connection with the free removal of involved portions of the left colon, as, for example, in the excision of the sigmoid flexure for early cancer.

Again, in favour of the operation it must be noted that gland implication occurs very late in connection with rectal cancer, and that metastases are met with only at a quite late period in the disease. It would appear, then, that if a free excision could be carried out at an early period, a complete cure should follow. To secure so admirable an end, an operation of no little severity would be justifiable. The records of the operation show that patients have lived for six, ten, and twelve years after the excision without exhibiting any sign of recurrence.

These favourable cases are, however, of rare occurrence. The proportion of "cures" after excision—*i.e.* the proportion of cases which are free from recurrence at the end of three years —is about 15 per cent. This is calculated from a large total—over 1,500 cases; and it must be remembered that, as a rule, these would be selected or comparatively favourable ones. On the other hand, the majority of these operations were done chiefly by Kraske's method, and by more recent methods much better results have been obtained. Thus, of eight cases

recorded by Lockhart-Mummery there were seven recoveries, some with perfect control; and Hartmann has recorded twelve cases treated by the same method—complete perineal resection—with only one death and three recurrences.

The arguments which must be used against the operation are these:—It is a serious, difficult, and dangerous procedure. So far as one can judge from the collections of published cases, the death-rate will be between 15 and 20 per cent.

The deaths have been due, for the most part, to shock, hæmorrhage, cellulitis, and peritonitis. That the duration of life has been extended in those who have survived the operation admits of no doubt, and it is also certain that some patients have exhibited no recurrence at the end of ten years and more. On the other hand, it would appear that a recurrence takes place in the majority of the cases, and that a permanent cure is comparatively rare.

That free removal which is essential to the success of an excision operation for cancer is difficult to carry out in dealing with the rectum. It is seldom that cases in an early stage are found: it is remarkable, indeed, how advanced the growth usually is when first discovered. Patients may have symptoms of bowel trouble for months before they reach a state compelling them to consult a medical man. Not only are the cases few which present themselves at a quite early period, but in any example—not in the commencing stage—it is not always possible to determine from digital examination the exact limits of the growth. Over and over again the growth is found at the operation to be more extensive than was suspected, and to have invaded the tissues to a wider degree than was supposed; over and over again it has to be allowed that the operation was undertaken too late, and that the condition found leaves very little hope of a successful excision. It is rare, indeed, for the surgeon to find upon exposing the part at the operation that the disposition of the growth is more favourable than he anticipated. These difficulties are now, however, being greatly decreased by the aid of the sigmoidoscope; by its use not only

is diagnosis more readily made in the early stages, but the extent of the disease, and the possibility of its complete removal, are more easily determined.

As regards the operation to be selected, all cases low down and freely movable should be treated by the perineal method, Quénu's incision being made. With the perineal operation for this variety of case, the mortality in 569 cases was 13.5 per cent. (Tuttle). By its means the sphincters are preserved and complete control may be regained, and under the more recent methods of treatment the likelihood of sepsis is considerably decreased. In the case of women the vaginal modification should be used if there be any fixation of the growth to the posterior vaginal wall. By this operation the affected part of the rectum may be readily removed, and its percentage mortality is not much higher than that of the partial perineal method, 14.3 per cent. (Tuttle).

In the case of the complete perineal removal the difficulties are greatly increased. The meso-rectum and meso-sigmoid have to be clamped high up, at a considerable distance from the surface of the wound. The difficulties of separating the gut high up and of accurately suturing the peritoneum are considerable, and nothing seems to be gained over the combined perineo-abdominal method.

The combined method is the operation of choice in the great majority of cases, all those, in fact, in which the disease is not situated in and limited to the lower part of the rectum. By its means the extent of the disease is accurately determined, and the presence or absence of secondary deposits in the glands investigated, a condition which has to be left to chance in the sacral and perineal methods. The vessels can be easily and securely ligatured, and the sigmoid freely mobilised; and any excessive tension on the gut avoided. Should it be found that the mesentery is not of sufficient length to allow for this, the upper end of the gut can be readily brought out in the iliac fossa, whilst such a condition in the perineal operation could not so readily be determined, or, if determined, so easily dealt

with. The anus with the sphincters can be retained, and, in a large number of cases, control regained.

The abdominal operation is of value where the growth is high up and the gut can be readily divided above and below, the lumen of the bowel then being restored either from the abdomen or after invagination. Such cases are, however, few in number, and it is usually found that whereas division is easily carried out above, the growth extends so far down that some form of perineal operation is necessary to remove it and to secure accurate apposition of the ends of the gut.

Kraske's operation, although it has been largely practised, has but little to recommend it. It is a severe and difficult operation, and always accompanied with much shock to the patient. It is difficult to obtain an accurate end to an anastomosis in this position, and hence sepsis is common. This is followed by the presence of a foul chasm in the perineal and sacral regions, and later on by sinuses and fistulæ which may extend far and wide; the portion of bone, if the resection has been only temporary, is very liable to necrose, and the sepsis may be followed by contraction and obstinate stricture. If the upper end of the gut cannot be brought down, and has to be fixed to the skin in the upper part of the wound, the patient is left with an anus over which he has no control, and situated in a position in which even mechanical control cannot be readily exercised. During the course of the operation the glands cannot be thoroughly examined for metastases, and the amount of gut which can be removed is much less than in the combined operation. Indeed, the sacral method is a procedure which fails to reach the high standard of excellence that can be claimed for the great majority of modern surgical operations, and the surgeon must well weigh the probabilities and the claims of the procedure before he undertakes it.

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